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VOL. CXXXIII.—No. 3453] LONDON: FRIDAY EVENING, MARCH 3, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Civil Engineer Required by the GOVERNMENT OF ZANZIBAR for one tour of 20 to 30 months' service, as an ASSISTANT ENGINEER on WATER SUPPLY. Salary £700 per annum. Free quarters and first-class passages.

Candidates, preferably single, must be A.M. Inst. C.E. or possess similar professional qualifications, and must have had good practical experience on Waterworks. The person appointed will be required to Lay-out and Supervise the Construction of Waterworks, Pipe Line and other details.

Apply at once, in writing, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/Zanzibar 11,271. 7581

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of—

WASHERS, STEEL, SPRING.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 17th March, 1922.

T. RYAN,
Director-General.
7551

City and Royal Burgh of Dundee.
ELECTRICITY DEPARTMENT.

The Corporation invites TENDERS for the following WORKS to be executed at Carolina Port, Dundee:—

1. REINFORCED CONCRETE PILING and FOUNDATION WORK for CIRCULATING WATER PIPE LINE.
2. SUPPLY, DELIVERY, and LAYING of about 258 YARDS of 54in. C.I. PIPE and 29 YARDS of 30in. C.I. PIPE, &c.

Specifications, drawings, forms of Tender, and general conditions of contracts may be obtained from the undersigned on payment of a deposit of One Guinea, which will be refunded upon receipt of a bona fide Tender.

Tenders (sealed in envelopes provided) to be lodged with W. H. Blyth Martin, Esq., Town Clerk, City Chambers, Dundee, not later than by 10 a.m. on Wednesday, 22nd March, 1922.

The Town Council do not bind themselves to accept the lowest or any Tender.

H. RICHARDSON, F.R.S.E.,
General Manager and Engineer.
Electricity Department, Dundee,
28th February, 1922. 7547

City of Leicester.
STEAM BOILERS, &c., FOR ABBEY SEWAGE PUMPING STATION.

The Sewage Works and Farms Committee invite TENDERS for:—

(1) LANCASHIRE BOILERS.
(2) MECHANICAL STOKERS and COAL CONVEYING PLANT.
(3) SETTING of the BOILERS.

Forms of Tender, &c., may be obtained at my office on payment of the sum of £2, which will be returned on the receipt of a bona fide Tender. Cheques, &c., to be made payable to the Corporation of Leicester.

Applications should state section desired.

Sealed Tenders, on the forms supplied, addressed to the "Chairman of the Sewage Works and Farms Committee, Town Hall, Leicester," must be delivered not later than 20th March, 1922, and endorsed "Tender for Boilers, &c."

The Committee do not bind themselves to accept the lowest or any Tender.

E. GEORGE MAWBEY, M. Inst. C.E.,
City Engineer and Surveyor.
Town Hall, Leicester,
21st February, 1922. 7505

Edmonton Urban District COUNCIL.
TENDERS FOR HEATING AND HOT WATER FITTINGS.

The Edmonton Urban District Council invite TENDERS for the HEATING and the SUPPLYING of HOT WATER FITTINGS for their Cleansing Station adjoining the Baths at the Town Hall, Edmonton.

Form of Tender and full particulars may be obtained of the Engineer to the Council, Mr. Cuthbert Brown, Town Hall, Edmonton. It will be a condition of contract that the firm whose Tender may be accepted shall pay to all workmen in its employ wages not less, and observe hours of labour not greater than the rates of wages and hours of labour in force within the district.

Sealed Tenders, which must be upon the form supplied by the Council's Engineer, endorsed "Tenders for Heating, Cleansing Station," to be delivered at my office not later than Twelve o'clock Noon on Wednesday, the 15th day of March instant.

The Council do not bind themselves to accept the lowest or any Tender, and any person whose Tender may be accepted will be required to enter into a proper contract and to provide such sureties as the Council shall direct.

By Order,
FREDK. W. CLAXTON,
Clerk to the Council.
Town Hall, Edmonton,
1st March, 1922. 7501

The Great Indian Peninsula RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

No.		Fee for Specification.
1.	CAST IRON POT SLEEPERS	£1
2.	TIE BARS, GIBS and COTTERS	10s.
3.	STEEL RAILS and FISHPLATES	£1
4.	STEEL FISH BOLTS, SPIKES, &c.	10s.
5.	TYRE RETAINING RING BOLTS and NUTS	5s.
6.	CARRIAGE DOOR HANDLES, HINGES, &c.	10s.
7.	CRANKED FISHPLATES	5s.
8.	RAILWAY TICKETS	10s.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Cast Iron Pot Sleepers," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 14th March, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 1st March, 1922. 7580

The Engineer

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American 300,000 K.W. Electric Power Station.

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Railway Brakes.

Electric Welding for Ship Construction.

Diesel Pumping Plant for Trinidad.

A Position Line Slide Rule.

PUBLIC NOTICES

Great Southern and Western Railway (Ireland).
CONTRACTS, 1922.

The Directors of the Great Southern and Western Railway Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES for three months commencing 1st April, 1922:—

	No. of Form.		No. of Form.
Acid, Sulphuric	3D	Glass and China Sundries	27B
Asbestos Sheeting, &c.	40	Hardware (Sundry)	17
Baskets	10	India Rubber Goods	9A
Bolts, Nuts, and Rivets	15	Implements, Sundry	21
Brooms and Brushes	13	Iron Tubes and Fittings	2D
Brass Fittings for Carriages	18	Leather	12
Do. do. for Water	26A	Locks and Keys	9
Do. do. for Gas	26B	Mats, Fibre	10
Canvas and Sacks	6	Nails	21
Castings, Mall. Iron	11	Packings	40B
Clothing, Oil	9B	Plumbago	41
Do., I.E. Proofed	9B	Railway Fastenings (Iron)	16
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Grindstones	28	Wicks	5
Glass, Sheet and Plate	27A	Wire, Fence and Signal	30A
		Wirework	30B

Forms of Tender can be obtained on payment of 1s. each from the Stores Superintendent, General Stores Department, G.S., and W.R., Inchicore, Dublin. Applications for forms by post must be accompanied by postal order. Stamps cannot be accepted. All inquiries for information should be also directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department on and after the 3rd inst., between the hours of 10 a.m. and 4 p.m. (except on Saturdays).

Tenders must be enclosed in the special envelope supplied for the purpose with each schedule, and must be posted so as to be with the undersigned before 10 a.m. on Wednesday, 15th March, 1922.

The Directors will not consider any Tender unless it is furnished on the Company's form, and do not bind themselves to accept the lowest or any Tender.

By Order,
ROBERT CRAWFORD, Secretary.
Kingsbridge Terminus, Dublin.
March, 1922. 7570

Royal Gwent Hospital, Newport, Mon.
TO HEATING ENGINEERS.

The Directors of the Hospital invite Heating Engineering Firms to submit SCHEMES for HEATING and HOT WATER SUPPLY to the new Out Patients' Department, for NEW BOILERS, and for such ALTERATIONS as may be required to the existing Heating Installation, together with TENDERS for the work.

Firms desirous of tendering may obtain copies of the plans and particulars upon application to us, accompanied with a deposit of £5 5s., which will be returned upon receipt of a bona fide Scheme and Tender.

All applications for particulars must be sent not later than 17th March, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

GRIGGS and VAUGHAN,
Architects.
Metropolitan Bank Chambers,
Newport, Mon. 7556

PUBLIC NOTICES

Midland Great Western Railway of Ireland.
GAS ENGINE FOR SALE.

The Directors of the above Company are prepared to receive TENDERS for the SALE of—

ONE 75 maximum B.H.P. NATIONAL SUCTION GAS ENGINE, together with Generator, Charging Hopper, Fuel Container, Scrubber, &c., complete.

Makers, the National Gas Engine Company.

The engine was supplied new to this company in the latter half of 1917, and its condition is equal to new.

Purchaser to remove engine at his own expense, but the Company will provide crane to facilitate removal at purchaser's risk.

The engine can be inspected, and full particulars obtained on application to Chief Engineer's Office, Broadstone Station, Dublin.

Tenders to be forwarded, addressed to the Chairman, Broadstone Station, Dublin, so as to reach him not later than Monday, 20th March, 1922.

The Directors do not bind themselves to accept the highest or any Tender.

PERCY A. HAY,
Secretary.
Broadstone Station, Dublin,
28th February, 1922. 7582

Swansea Harbour Trust.

The Swansea Harbour Trustees invite TENDERS for the REPAIR of certain FERRO-CONCRETE QUAYS in their King's Dock, by means of the Cement Gun. The quays may be inspected, and further particulars of the nature of the repairs to be executed may be obtained on application to the Trustees' Engineer, Mr. A. O. Schenk, M.I.C.E., Harbour Offices, Swansea.

Tenders, marked "Repairs to Quays," should be delivered to the undersigned not later than 10 a.m. on Friday, the 24th March, 1922.

The Trustees do not bind themselves to accept the lowest or any Tender.

TALFOURD STRICK,
Clerk.
Harbour Offices, Swansea,
25th February, 1922. 7544

Swansea Harbour Trust.

The Trustees invite TENDERS for the SUPPLY and DELIVERY of the following:—

950 NEW CREOSOTED SLEEPERS, 9ft. by 10in. by 5in.

Approximately 3300 cu. ft. 12in. by 6in. PITCH PINE CROSSING TIMBERS, in length varying from 9ft. to 26ft. A schedule of length will be supplied.

About 47 Tons CAST IRON RAILWAY CHAIRS, approximately 44½ lb. each.

About 5 Tons of 7½in. by ¾in., and about 5 Tons of 8½in. by ¾in. FANG BOLTS, with 3in. Triangular Shoes.

Further particulars may be obtained of the Trustees' Engineer, Mr. A. O. Schenk, M.I.C.E., Harbour Offices, Swansea.

Tenders, sealed and marked "Railway Material," to be delivered to the undersigned on or before 17th March, 1922.

The Trustees do not bind themselves to accept the lowest or any Tender.

TALFOURD STRICK,
Clerk.
Harbour Offices, Swansea,
March 1st, 1922. 7579

SITUATIONS OPEN

WANTED, ENGINEER as REPRESENTATIVE in the South Wales district for the Sale of Turbo-generating Plant, High-speed Engines, &c. Please state experience, age, and salary required.—Address, P5013, The Engineer Office. P5013 A

PUBLIC NOTICES

TO FIRMS WANTING CONTRACTS.

Quotations are Required for MANUFACTURE in batches of 250, on repetition lines, of lightly constructed Brass Hand-operated AIR PUMPS for low pressures, 2in. bore by 15in. stroke, with solid-drawn tubular barrel, single disc valve, and special two-way cock. The product is simple and easily made in any plain machine shop. Prices should be as if for a single lot of 250, although expected to be repeated from time to time.

The advertiser does not bind himself to accept the lowest or any quotation. Drawings of complete article, showing all production data, will be sent upon payment of fee of 15s. 6d., which will not be returned under any circumstances, to Mr. H. GEORGE HARLEY, Consulting and General Engineer, Grand-avenue, Camberley. 7587

SITUATIONS OPEN (continued)

WANTED, an ENGINEER with Up-to-date Knowledge of Mass Production Methods to Design and Construct Works and Initiate New Monopoly Manufacture. An exceptional opportunity for a keen ambitious man of the highest organising and executive abilities; must be prepared to speculate £500. Remuneration by results, but should be worth £2000 per ann. up for the right man. Age 30 to 40.—Address, P5037, The Engineer Office. P5037 A

WANTED IMMEDIATELY, TECHNICAL ASSISTANT, with Drawing-office Experience; knowledge of Steam Turbine and General Power Plant Work essential.—Copies of testimonials and details of experience, together with statement as to salary required, to be addressed to 7565, The Engineer Office. 7565 A

WANTED, in a Municipal Engineer's Office in the North of England, a young MECHANICAL ENGINEER with good theoretical and practical experience. A knowledge of the handling of iron and materials would be an advantage.—State age, full particulars of experience, and salary to Box 999, c/o Judd's, 97, Gresham-street, London, E.C. 2. 7546 A

CARBON DRILLS OR SMALL TOOLS.—We WANT a GENTLEMAN who has a good connection with the above tools. A progressing BERTH is OFFERED with DIRECTORSHIP.—Address, 7567, The Engineer Office. 7567 A

CIVIL ENGINEER REQUIRED IMMEDIATELY for the POSITION of AGENT-IN-CHARGE of the works for Constructing Large Masonry Dams in North Brazil. Applicants should have held a similar position previously, and should speak Portuguese—Address, P5024, The Engineer Office. P5024 A

ELECTRICAL ENGINEER

LARGE, Esteemed, Technical PORCELAIN MANUFACTORY in Scandinavia WANTS a capable REPRESENTATIVE, with first-class connections. Excellent references.

Write, H. G. 2446, Box 709, Dorland Agency, Ltd., 16, Regent-street, S.W. 1. P5021 A

ESTIMATING and SALES ENGINEER, Capable of Designing Plant, Preparing Estimates and to Take Sole Charge of Department devoted to By-products Recovery Plant; must have thorough knowledge of Distillation, Rectification and Scrubber Plant. Position offers exceptional prospects to engineer possessing ability and initiative.—Address full particulars, stating past experience and salary, to 7592, The Engineer Office. 7592 A

THE MIDDLESEX HOSPITAL, W. 1.—WANTED, ENGINEER, with Mechanical and Electrical experience, who can also act as Clerk of Works.—Apply, stating experience, age and salary required, to SECRETARY-SUPERINTENDENT. 7543 A

PLANER DRIVE, Described "Engineer," July 29th, 1921, and "Machinery," July 28th, 1921, and "Machinery Market, November 4th, 1921. LOCAL REPRESENTATIVES REQUIRED, with entree to engineering works. Only responsible men of standing should apply, describing connections, area, and method of procedure.—NEWTON BROS. (Derby), Ltd., Derby. P4961 A

REQUIRED AT ONCE, a Good PRACTICAL MAN, capable of Supervising Running Repairs and Maintenance Work on Railway Wagons; first-hand knowledge of Wagon Construction and Repair Work essential.—Apply, giving full information as to experience, wages required, age, &c., to "WAGON," c.o. 19, Corporation Street, Birmingham. P5033 A

RESEARCH ENGINEER (London) has VACANCY for YOUNG GRADUATED ENGINEER, with sound practical experience.—Address, P5019, The Engineer Office. P5019 A

TRAVELLERS REQUIRED by Old-established firm to introduce highly efficient Plastic Packing suitable for all types of stuffing-box. Attractive commission.—OMEGA, 376, c.o. Deacon's, Leadenhall-street, E.C. 3. 7574 A

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DRAUGHTSMAN REQUIRED for Estimating Dept. of large Bridge and Construction Works on North-East Coast; must have good knowledge of details and modern practice in Steel-framed Building Construction and able to take out Stresses and Quantities quickly.—Address, stating age, experience and salary required, 7540, The Engineer Office. 7540 A

INDIA.—REQUIRED IMMEDIATELY, Experienced WAGON SHOP FOREMAN, unmarried; 5 years' engagement, free passage out and home. Good opportunity for thoroughly capable man.—Address, giving experience and copies of testimonials, 7573, The Engineer Office. 7573 A

FOUNDRY FOREMAN REQUIRED for Modern Foundry in the Midlands dealing with General Engineers' Castings (Loam and Green Sand) up to 5 tons. Applications are invited from energetic and progressive men, capable of producing good work and thoroughly accustomed to piecework. State age, previous experience, salary required and whether Union or non-Union.—Address, 7577, The Engineer Office. 7577 A

EGYPT.—WANTED, a WORKING ERECTOR, with experience of controlling Arab or Eastern labour, to erect small High-pressure Pumping Station, Semi-Diesel Engine and Pipe Line.—Reply, SINAI, c.o. Gilbert Gillies and Co., Ltd., Kendal. 7555 A

WANTED, Experienced FITTER. Capable of Taking Charge of all Machinery Repairs, including Steam, Gas and Electrical Plant.—Address, 7585, The Engineer Office. 7585 A

SITUATIONS WANTED

WANTED, RESPONSIBLE POSITION, Factory Management, Construction Contracts or Agency; would consider partnership in sound concern; engineer (42), A.M.I. Mech. E.; wide experience, practical and energetic; first-class references.—Address, P5030, The Engineer Office. P5030 B

ADVERTISEMENT MANAGER SEEKS an APPOINTMENT in the provinces.—Address, P5010, The Engineer Office. P5010 B

A MECH. ENGINEER, Buying and Selling Exp. home and abroad, commercial exp. up to and including general managership, correspondence (French, German and Spanish), REQUIRES SITUATION as Machinery Buyer. Refs. undeniable; free first week in London.—Address, P5029, The Engineer Office. P5029 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide Knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 3. 7520 B

CIVIL ENGINEER, 20 Years' Experience Public Works, chiefly railways and docks, fluent Spanish, good testimonials, DESIRES WORK, temporary or permanent.—Address, P5009, The Engineer Office. P5009 B

COMPANY SECRETARY, COMMERCIAL MANAGER, with long and varied engineering experience in London and Provinces, SEEKS SIMILAR POST; experience includes company secretarial work, organisation and administration, buying, selling, travelling and publicity; accustomed to control commercial side of business.—Address, P5042, The Engineer Office. P5042 B

ENGINEER MECHANIC (40), Experienced in Plant lay-out and general engineering, DESIRES responsible POSITION, near London. Can take complete charge of plant and do all running repairs.—Address, P5036, The Engineer Office. P5036 B

TO ENGINEERS, MANAGING DIRECTORS, AND MANUFACTURERS.

GENTLEMAN (45), M.I.M.E., A.M.I.E.E., SEEKS APPOINTMENT; 5 years' organising and administrative experience in electrical and mechanical engineering drawing-office, estimating cost and stores systems, methods of payment by results, works buildings, installation, equipment, planning and lay-out, power schemes and contracts. Has controlled successfully large works and staffs employing 1500-6000 hands for last twelve years. Excellent credentials. Will accept reasonable salary with prospects or entertain partnership. Replies will be treated confidentially.—Address, P4984, The Engineer Office. P4984 B

GENTLEMAN, with Sound Connection in Eastern Counties, is OPEN for an ENGAGEMENT, not necessarily in Eastern Counties; apprenticed Messrs. Humbers, Ltd., Coventry; for past 2½ yrs. E.C. representative to Messrs. J. Tullis and Son, Ltd., 5, Lloyd's-avenue, E.C. 3. Replies treated confidentially.—A. PRESTON CRAGG, 29, Philip-road, Ipswich. 7571 B

INCREASE OUTPUT in Your WORKS by Speeding-up machines to maximum, and fix bonus or piece prices on increased rate of output; 10 years' experience, all class of machines.—Address, P5017, The Engineer Office. P5017 B

MECHANICAL ENGINEER, Late Manager of small works, SEEKS ANY RESPONSIBLE POST where 50 years' good all-round general experience (works and office) are of value.—ROAD, 30, York-road, Hitchin. P5040 B

MECHANICAL ENGINEER (32), Single, DESIRES POSITION of WORKS MANAGER or ENGINEER; practical and technical experience covering 16 years; willing to go abroad.—Address, P5000, The Engineer Office. P5000 B

MECHANICAL ENGINEER and DRAUGHTSMAN, London, 14 yrs. shops, 12 yrs. office, all-round experience, including inventions and low-temperature carbonising.—Address, P5045, The Engineer Office. P5045 B

PRACTICAL ENGINEER (Age 32), 13 yrs. Machine shops, apprenticeship, I.C.S. training, 3 yrs. up-to-date D.O., SEEKS OPENING as Shop or Maintenance Foreman or similar; strong mentality, influential refs.; good correspondent.—Address, P5028, The Engineer Office. P5028 B

QUALIFIED ENGINEER (38), A.M.I. Mech. E., DESIRES POST as MANAGER or ASSISTANT to small up-to-date firm. Lifetime varied experience, shops and drawing-office; prepared to take small financial interest. Moderate salary on mutually agreed basis.—Address, P5008, The Engineer Office. P5008 B

YOUNG ENGINEER, 22 Years; Experience, 7 years machine shop, electrical and internal combustion engine work, SEEKS progressive POSITION, home or abroad.—E. LAKER, 8, North-road, E. 17. P5007 B

YOUNG ENGINEER (23), ex-Officer, M.C., B.Sc. (Hons.), practical experience, DESIRES START in commercial or managing side in any capacity; small commencing salary required.—Address, P5023, The Engineer Office. P5023 B

TECHNICALLY TRAINED MARINE ENGINEER (27), 9 years shops, D.O., and sea experience with firms of repute, Extra B.O.T. and college certificates, DESIRES POST as Assistant to Works Manager or Consulting Engineer.—Address, P4993, The Engineer Office. P4993 B

WORKS MANAGER REQUIRES POSITION. Wide experience all branches, tactful organiser, proved record; home or abroad.—Address, P4983, The Engineer Office. P4983 B

DRAUGHTSMAN (28), A.F.R.Ae.S., Technical Education, Works training, 6 years' aircraft design in D.O., SHORTLY DISENGAGED; excellent refs.—Address, P5027, The Engineer Office. P5027 B

SITUATIONS WANTED (continued)

DRAUGHTSMAN REQUIRES POST; Experienced in automatic machines, jigs, tools, gearing, motor cars; general work.—Address, C. WATTS, 17, Braydon-road, Stamford Hill, London, N. 16. P5006 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design, and general engineering, DESIRES SITUATION; London or South Coast.—Address, P5005, The Engineer Office. P5005 B

MECH. ENGINEER DRAUGHTSMAN (34), Designer, plant, lay-out, special chain machines, electrical machines, gas furnaces, buildings, general work; technical knowledge; shops and office 10 years.—H. L., "Rydal," Hyde-street, Hull. P5018 B

LADY TRACER, with 15 Years' Experience, REQUIRES POSITION in town or country.—Address, P4964, The Engineer Office P4964 B

SENIOR DRAUGHTSMAN or ASSISTANT WORKS MANAGER; valuable light car, cyclecar, petrol and steam lorry experience; designs cleaned up for cheap production; proved works organiser; engagement required any capacity.—Address, P5046, The Engineer Office. P5046 B

SITUATION in DRAWING-OFFICE REQUIRED by TURNER IMPROVER, age 23; knowledge of drawing, tracing and mathematics, &c.; 7½ years' workshop experience.—Address, J. E., 66, Greenlane, Letchworth, Herts. P5002 B

FOREMAN ANGLE and FORGE SMITH SEEKS SITUATION; Admiralty, merchant shipbuilding, boiler and constructional work; excellent refs.; home or abroad.—Address, P5028, The Engineer Office. P5028 B

FOREMAN PATTERNMAKER SEEKS RE-ENGAGEMENT; age 32; practical experience all classes of patterns, machine tools, press tools, carriage and wagon rolling stock; accustomed lady sole charge.—Address, P5025, The Engineer Office. P5002 B

ENGINEER MECHANIC (42) SEEKS JOB. Installation and charge of plant abroad; experienced gas, steam; speaks Spanish; used foreign labour.—Address, 7588, The Engineer Office. 7588 B

FITTER ERECTOR, 29 Years of Age, Outdoor preferred; good experience of steam engines, boilers, pumps, machine tools and general maintenance work, or charge of large plant.—Address, P5034, The Engineer Office. P5034 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.

46, Watling Street, London, E.C. 4.

Established seventy years.

PARTNERSHIPS and ACTIVE DIRECTORSHIPS WANTED in Mechanical, Constructional, Electrical Engineers, &c., for Clients with technical experience and capital from £1000 to £20,000.—GILBERT and PRATT, 18, Walbrook, London, E.C. 4. Ex C

MECHANICAL ENGINEER DESIRES ACTIVE PARTNERSHIP with responsible man, who can introduce one of two good specialities for manufacture.
Advertiser has had extensive manufacturing experience, is technically trained, and has facilities for the construction of light machines or specialities.
The type of speciality desired is one which is built chiefly of castings requiring general machining. High-class repetition work preferred.
Address, P5033, The Engineer Office. P5033 C

PRIVATE LIMITED COMPANY (Yorkshire), Engaged in Constructional Steel and General Plate Work, with good works and plant, employing 30 to 40 workpeople, and with plenty of room for extension, REQUIRE CAPABLE MAN to act as MANAGING DIRECTOR and invest £3000 to £5000.—Address, in first instance, P5035, The Engineer Office. P5035 C

AGENCIES

ADVERTISER, Calling on Engineers in Bradford district, is OPEN to TAKE UP ADDITIONAL LINE. Well known in the district.—Address, P5012, The Engineer Office. P5012 B

AGENTS WANTED to Sell Special Case-hardening Compound. Practical men. State experience and terms.—Address, 7522, The Engineer Office. 7522 D

CARBON DRILLS.—Exceptional OPPORTUNITY for an AGENT to take up this line in Manchester, Leicestershire, also Newcastle districts. Prices are easily competitive and quality guaranteed.—Address, 7586, The Engineer Office. 7586 D

ENGINEERING COMPANY, Manufacturing Welded Steel Fittings, Flanges, Pipe Lines, Steam and Refrigerating Coils, OFFER the SOLE AGENCIES for the following districts:—The Midlands, South of England, West of England, and the East Coast.—Address, with fullest particulars, stating counties which would be covered, 7542, The Engineer Office. 7542 D

FIRM of MECHANICAL and ELECTRICAL ENGINEERS, with developed office organisation and extensive connections, are prepared to CONSIDER LONDON REPRESENTATION of firms of repute.—Address, 7586, The Engineer Office. 7586 D

LONDON FIRM, with Sole Agency for French Manufacturers of Rolling Stock, Castings, Forgings, Cranes, &c., are OPEN to APPOINT SUB-AGENTS in Great Britain.—Address, 7477, The Engineer Office. 7477 D

REFRIGERATING MACHINES.
MANUFACTURERS of "CO2" Cooling Cabinets, Ice-making Machines and Ice Cream Freezers, reliable, efficient and competitive, invite APPLICATIONS from first-class ENGINEERING FIRMS with selling organisation, show-rooms and mechanics.—FRIGORE, L. Garvin and Co., 99, Leadenhall-street, London, E.C. 3. 7575 D

Bagshaw's Wrought Iron Pulleys,
as used in Government Departments, are the strongest, cheapest, and best in the market. Quick delivery given. Also FRICTION CLUTCHES for all purposes, SHAFTING, WHEELS, and PEDESTALS. List free.—J. BAGSHAW and SONS, Ltd., Engineers, Batley, Yorkshire.

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For continuation of For Sale Advertisements, see page iii.

FEBRUARY.

Trades Unions and Works Management.

A WEEK ago employers posted notices in their works informing members of the Amalgamated Engineering Union that, owing to the adverse vote of the union on the question of overtime, their services would not be required after Saturday, March 11th. The matter which led to this deplorable issue is a clause in a Memorandum approved by the executive of the Union, which runs as follows:—"The trade union shall not interfere with the right of the employers to exercise managerial functions in their establishments, and the Federations shall not interfere with the proper functions of the trade union." The prime object of the employers is to restore to their own hands the right to say when overtime is to be worked. On the question going to the ballot 50,240 men voted against and 35,525 in favour of acceptance. As the total membership of the union is well over 400,000, the adverse vote bears a very small proportion to the whole—about 12 per cent.—and it was hoped that endeavours which were made on Tuesday last to re-open negotiations would be effectual. Unfortunately, the executive of the A.E.U. endeavoured to saddle the employers with the onus of finding a way out of the impasse, and as the employers, very naturally, insisted that the rejection by the members of the union of the recommendation of their executive was a domestic affair, no progress could be reported after a conference which lasted for four hours. There is, however, yet a week to run before the notices expire, and it is still hoped that in the next few days some means of calling for a new ballot may be found.

Institution of Electrical Engineers Jubilee.

THE meetings which were held towards the end of the month in commemoration of the first gathering of the Society of Telegraph Engineers, which subsequently became the Institution of Electrical Engineers, were undoubtedly a great success. Starting with Dr. Fleming's admirable experimental lecture on the work of Michael Faraday, the programme was carried through without a hitch, although owing to illness, the President, Mr. J. S. Highfield, was unfortunately unable to attend. Whilst the importance of Faraday's discoveries cannot be overestimated, immense difficulties were encountered in the application of those discoveries to practical work, and no praise is too great for those who, despite innumerable obstacles and disasters, carried on and ultimately emerged from their struggles triumphantly. To all it was a great pleasure to hear some of those men speak of their early experiences and describe how obstacles were grappled with and overcome. Notwithstanding the very arduous and worried lives which these pioneer workers must have lived in their young days, many of them seem little the worse for it. They told their stories with real enthusiasm and were obviously glad to tell them, for they were about the work they enjoyed and which ultimately made electrical engineering the great and important industry it now is. Needless to say, many highly amusing incidents were related, and many extraordinary stories were told; but, of course, with the time at their disposal none of the speakers were able to give more than a very brief outline of what they really went through. The happenings at the Deptford station alone would fill a fair-sized book, and it is a great pity that Dr. Ferranti or some other qualified member of the electrical profession has not yet told the story in full.

The Railway Annual Meetings.

THE annual meetings of all the principal British railway companies were held between the 10th and 28th. As far as railway engineering is concerned there is little to report. At not a single meeting was there any mention of any proposed expennditure on capital account nor intimation given as to some proportion of the thirty millions, just paid to the companies by the Government as compensation, going into the road or rolling stock in return for the arrears of maintenance and renewal for which the money, and thirty millions more a year hence, is being paid. The fifteen principal companies drew, in the aggregate, twenty-one millions, and of this sum four millions or 19 per cent. have been taken to assist in paying a dividend. The main subject discussed was the effect of the Railways Act, particularly in its future effects as a result of the grouping of the companies. Most of the chairmen compared the original proposals of Sir Eric Geddes, as outlined in June, 1920, with what appeared in the Bill when it was presented eleven months later and in the resultant Act. Great satisfaction was expressed at the happier relations with the men, and particular mention was made of the loyalty of Mr. J. H. Thomas and other members of the Labour Party in supporting the companies against the Government when the latter wanted the men to be represented on the directorate. The advantages to the companies and to traders that will be gained by the establishment of the Railway Rates Tribunal were enlarged upon, but no indication was given of any early reduction in rates or fares.

Helicopters.

EXPERIMENTAL work carried out in France is giving definite results that offer at least some possibility of important developments in the future of aviation. The helicopter has always been regarded as an illusory application which may be perfect in principle but exceedingly difficult of realisation, and while more or less successful attempts have been made to raise a machine vertically from the ground, most experimenters have found it difficult to make horizontal flights and to prevent the machine from rotating. M. Pescarra, an Italian engineer, has probably done more than anyone else in the way of obtaining practical results. His helicopter was shown at the last aeronautical exhibition in Paris, and since then he has been developing his ideas with the aid of funds supplied by the French Government, which is taking a keen interest in this new phase of aviation, as well as in everything else connected with aerial flight. The Pescarra apparatus weighs about 800 kilos. and is fitted with an engine of 180 horsepower, driving a number of horizontal propellers in opposite directions whereby the effects of rotation are eliminated, or at any rate considerably reduced. In preliminary trials carried out during the past month the machine repeatedly left the ground and was maintained for several minutes at a height of 3ft. or 4ft., when the apparatus itself was almost stationary. While the trials are satisfactory so far as they have gone they are yet far from conclusive, but it is obvious that progress has been made with the helicopter, and its future will be looked forward to with interest, not less in this country, where Mr. Louis Brennan's machine is nearing completion, than in other lands.

The Buxton Explosion.

ABOUT the middle of the month the official report on the explosion of the boiler of a London and North-Western locomotive at Buxton on November 11th last was issued—see THE ENGINEER, February 17th. In many respects it is a far better report than usual, for there was manifested at the inquiry less "law" and more "technology" than is commonly the case. Indeed, the inquiry was of a very searching character, and it is not the fault of Major Hall or Mr. Cranwell, who assisted him, if the ultimate cause of the explosion remains doubtful. The accident is attributed to excessive pressure, and the excessive pressure is presumed to have been due to the failure of the Ramsbottom safety valve to act. The evidence that the valves did stick is indeed pretty conclusive, but *why* they stuck is so far unexplained. Mr. Cranwell's suggestion that the sticking was caused by distortion of the seats owing to the low external temperature is unsupported by any experimental evidence and is unlikely in itself. The angle of the valve seat was 30 deg. instead of the usual 45 deg., but experiments appeared to indicate that the sharper angle acted properly, though in some cases Captain Beames found valves that failed to lift freely. The reporters made two recommendations which are willingly accepted by chief mechanical engineers—first, that the valve seats should be bored after being pressed into position; and secondly, that a cock should be so fitted that the pressure gauge might be readily tested against the safety valves. We may add our own recommendation that means should be provided to enable a driver at any time to satisfy himself that the safety valves are acting freely. Had the safety valve lever of No. 134 projected into the cab we can hardly doubt that one of the drivers who had reported the steam gauge as reading high would have touched it to make sure that the valves were not at fault.

Another Airship Disaster.

ON the 21st disaster overtook the United States Army airship Roma at Hampton Roads, Virginia. The vessel, it would appear, was carrying out tests with a large number of military and civilian passengers on board preparatory to a transcontinental demonstration flight. The exact cause of the accident is not yet quite clear, but according to report its origin is to be traced to the failure of the rudder when the vessel was carrying out a high-speed test. The airship became uncontrollable and dived downwards. In all probability no lives would have been lost had it not been for the fact that just before reaching the earth the vessel struck some overhead wires carrying high-tension current. She was instantly ignited, and in the ensuing fierce conflagration all but twelve of the forty-six men on board lost their lives. The Roma was a semi-rigid vessel of 1,200,000 cubic feet capacity, and was purchased by the United States from the Italian Government in February, 1921. She was shipped across the Atlantic in parts and re-erected in America. For a time she was inflated with helium for experimental purposes, but just before the date of the disaster her contents of this valuable gas—representing, it is stated, the total amount at present available in the United States—were put into store and replaced by hydrogen. The vessel appears to have developed various defects before her end came. On one occasion a propeller failed and punctured one of the gas bags. Her engines, too, seem to have given trouble, for those with which she was originally fitted by her builders were replaced after her arrival in America by six "Liberty" engines. The disaster occurred within six months of the loss of the R 38, and in its essential features bears a close resemblance to that accident. Thus in both cases structural failures occurred while the vessel was being manœuvred at high speed. The subsequent features of the accident to the Roma should not be allowed to confuse the issue. The dirigible airship as we know it at present stands indicted as a failure. It must either be abandoned or allowed to rest quietly on the laboratory shelf until such time as the march of scientific discovery places at our command very different means and materials for its construction.

The R 38 Report.

Two days after the loss of the Roma the report was published of the Accidents Investigation Committee on the loss of the airship R 38 at Hull on August 24th of last year. In general, the Committee found that in order to fulfil the requirements laid down for the vessel the designers took risks by not availing themselves of the results of model experiments and by basing their calculations too extensively on the precedents set by earlier British designs of airships. The vessel as constructed failed to fulfil the prescribed requirements, and at the same time was structurally weak so far as manœuvring stresses were concerned. Professor Bairstow, a member of the Committee, calculated that the factor of safety under aerodynamic loading conditions that were known to have occurred was not above two, and that under conditions that might easily have arisen it would not have been above one. The design, it would appear, was satisfactory from the point of view of the strength provided to resist the forces and moments arising from the buoyancy and the distribution of the weight; but, from the point of view of manœuvring stresses, it was defective. In this connection it is to be noted that the instability of the vessel was such that large movements of the control organs were necessary in order to hold her on any set course, and that she was fitted with specially powerful control surfaces of a new design. The material of which she was built was in general up to specification, although the Committee found one or two weak members which, although they did not contribute to the disaster, were significant as indicating some lack of supervision during the construction period. The vessel met with disaster when manœuvring at high speed simply and solely because the dynamic stresses added to the static were in excess of what her structure could support. As in the case of the Roma, defects of a serious nature developed in the vessel on flights preceding that on which the disaster occurred. On the third trial, for instance, disaster was narrowly averted by the prompt action of the commander in steadying the vessel and relieving the stresses on certain amidship girders which had failed when the speed was increased to 50 knots.

Trade Reconstruction.

THE conclusion of commercial arrangements during the month between France and Poland and Czecko-Slovakia marks a new phase in the French policy of trade reconstruction that should not be overlooked. The policy aims at obtaining specific advantages for French trade and industry, and was inaugurated by the raising of import duties so that the country would be able to obtain the best terms possible by way of reciprocity. So far all other attempts to impose commercial arrangements have failed, because it scarcely seems possible to carry out a give-and-take policy with different countries without giving to some advantages over others. Where, however, France is able to impose her new method of trade expansion she may be able to derive benefits in the way of participating in industrial development,

for her policy is very closely allied to political influence, and at the moment it is bringing in the nations of the *Petite Entente* which are in need of assistance for the reconstruction of their industries. That the policy is not without drawbacks to countries that desire to maintain their commercial independence is shown by the resistance offered by Belgium, Italy and Spain, which have all refused to accept the French offers. Of far more immediate value as a means of reconstructing business is the American proposal to establish in France a Federal European Bank with a capital of 2500 million dollars, which will be guaranteed by a 20 per cent. reserve of gold to be sent over from the United States and a sufficient circulation of bankers' drafts for easily negotiable merchandise. The idea is, of course, to facilitate commercial exchanges between Europe and the United States, and the rapid improvement in the value of the franc during the month is at least an indication that the situation is much better than it has been for a long while past.

Manchester Ship Canal.

THE report of the directors of this great inland waterway, to which reference was made by our Manchester correspondent last week, serves to show how the foreign trade of the industrial north suffered during the past year. The amount of toll-paying merchandise traffic was less than in any year since 1901; but, nevertheless, the company was able to pay dividends, though on a much reduced scale, to all classes of shareholders. It would seem that, pending a material revival in the export and import trade of the country, there will have to be a further reduction in the price of labour if those who have provided the necessary capital to carry out and conduct such a vast undertaking are to receive a fair return on their investments. This view is emphasised very remarkably in that portion of the report which refers to the Bridgewater section of the undertaking, the net revenue from which was "favourably influenced" by the curtailment of the carriage of traffic that would otherwise have proved unprofitable owing to the high wages and working conditions of the men engaged upon it. It is a striking commentary on the industrial situation that the benefits of such an undertaking have to be denied to the trading community in order to avoid pecuniary loss to its owners.

Eight Hours' Day.

THE Parliamentary Committee appointed in France to investigate the effects of the operations of the Bill limiting the working day to eight hours completed its labours during the month, and although the object of the Committee was simply to collect evidence and not to present conclusions, it is understood that the Bill is likely to remain as it stands, but that full advantage will be taken of its reservations to increase the hours wherever necessary. In nearly every industry there are complaints that the limitation of working hours has considerably increased the charges, and in the case of shipping it has proved disastrous, since the French shipowners are no longer able even to make a pretence of competing with the foreign companies for freights. The eight hours' day is regarded as the main obstacle to a recovery of industrial prosperity. The Bill distinctly specifies that its application is conditional on the productive capacity of each man being maintained at the pre-war level, but, as a matter of fact, there has been a considerable reduction all round and wages have proportionately advanced, with the result that manufacturing costs are so high as to compel makers to agitate for higher protective duties. It is now generally admitted that the future prosperity of French industries depends upon an adjustment of wages to the work done, or, in other words, that the men must do more work for the wages received. This is especially the case in the colliery and textile industries, which are, in many cases, being carried on at a loss in face of foreign competition. There is no doubt that the forthcoming debate in the Chamber of Deputies will arouse considerable opposition from the Socialist element, but a reform is so inevitable that it is expected there will be no difficulty in modifying the application of the Bill, while preserving its principle.

The Blisworth Railway Accident.

THE third of the recent railway accidents caused by locomotive failures and the first fatal passenger train accident of the present year—that at Blisworth, London and North-Western Railway, on January 26th—was inquired into by Major Hall on behalf of the Ministry of Transport on the 1st of the month. The accident, in its cause and suddenness, was unparalleled. The right-hand step of the tender of the 4.35 p.m. express from Euston to Birmingham, which weighed about 2 cwt., became detached when approaching Blisworth, and fell on to a sleeper, whence it rebounded and struck the side panel of the brake compartment of the leading coach. It then rose and swept away all the glasswork in the passenger compartments of that vehicle, and at the last was strangely deflected to the right and into the path of the 10 a.m. express from Glasgow to Euston. It struck its engine in two places, and the tender in one, and hit the leading coach above the headstock, then rose and caught all the glasswork in that coach, coming finally to rest in the woodwork of the end compartment. As the down train was travelling at 60 to 65 miles per hour, and the up at about 35 miles per hour, the speed with which such damage was done was remarkable. The step was fastened to the footstep by two countersunk bolts and nuts, by eight bolts and nuts—four inside and four outside—to the headstock, and by two set screws to the hornblock. Whilst there was ample evidence that engine steps rarely require attention, it was made clear that this particular step had been reported five or six times since the tender came out of the shops after general overhauling on November 26th, and that the driver found some bolts loose when the engine was taken over at Bushbury on the morning of the accident and again before he left Euston.

The Air Conference.

THE second Air Conference organised by the Air Ministry was held on the 7th and 8th of the month at the City of London Guildhall. On the 6th those attending the Conference visited the London Terminal Aerodrome at Croydon, and inspected the machines and the arrangements—including those for night flying—that have now been provided at that station to meet the existing air traffic and the growth in it which is confidently anticipated during the coming season. On the 7th, under the presidency of the Secretary of State for Air, Mr. F. E. Guest, five papers were read at the Guildhall, namely:—"Civil Aviation," by Lord Gorell; "Aerial Transport To-day and To-morrow," by Colonel Bristow; "Airships," by Major Scott; "Research Work from the Designers', Constructors' and the Users' Points of View," by Major Green; and "The Progress of Research," by Brigadier-General Bagnall-Wild. On the 8th, with Lord Weir in the chair, these papers were discussed. The Conference was characterised by a distinct note of pessimism in certain quarters, particularly in the remarks made by Lord Weir and Mr. Guest. Nevertheless, others took a hopeful view of the situation—even with regard to airships—and urged that still more should be done by the Government towards assisting the aeroplane industry and civil aviation on to a sound commercial basis. It was satisfactory to learn from the Director of Research at the Air Ministry that many important investigations of fundamental importance to the technical equipment of the Royal Air Force are in progress, and that, however much civil aviation may languish, those in authority are apparently determined to proceed with the development of military aeronautics in an energetic manner.

A Technical Library for Manchester.

THERE are technical libraries and technical libraries, but the one and only *public* technical library in this country which engineers recognise as worthy of the name is that at the Patent Office in London. For many years the engineers in the north-western part of the country, of which Manchester may be said to be the centre, have felt that it should not be necessary for men in that great area to make a journey to the Metropolis when in search of technical information. Probably something would have been done to remedy this state of affairs ere now had not the war intervened. There were visions of a central engineers' building to house a really efficient library, to provide a meeting place for the various institutions and premises for a club for members of the engineering and allied professions. The club alone materialised, and has proved a boon to the engineers in the Manchester district. It was here that a few men prominent in the engineering industry were invited by Mr. Daniel Adamson a few days ago to dinner with the object of revitalising the subject, and amongst those invited were the presidents and chairmen of the local technical institutions, several aldermen of the city who are also engineers, together with Alderman Abbott, who is chairman of the Libraries Committee, and Mr. L. S. Jast, the city librarian. As a result of the informal discussion which took place it is probable that in the not very distant future the city will possess a technical library comparable with the commercial library already in existence, and worthy of the great industrial area which it is intended to serve.

Plastic Wood.

IN East Anglia, on the banks of the river Gipping, near Stowmarket, there is a factory where for something like eighty years cotton has been used as one of the chief ingredients in the manufacture of explosives; it is, in fact, the place where guncotton was first made on a commercial scale in this country. During the war the works naturally became of great importance, and extended along the little river to a length of about a mile and a-quarter, the staff was increased greatly, and vast quantities of cordite were manufactured. Now the demand for explosives is so small, comparatively, that their production has been handed over to other factories, and the works have been converted for the manufacture of products with such peaceful-sounding names as "Plastic Wood" and lacquer. The raw materials are, nevertheless, much the same as those used for making war-time explosives.

The proprietors of the works, Necol Industrial Collodions, Limited, have boldly struck out from the old routine and have put up new buildings and plant for the production of a variety of materials having cellulose nitrate as a base, several of which, it appears to us, should appeal strongly to engineers. Among these products there is the plastic wood just referred to. It has the consistency of the dough used in pastry making, and can be moulded into any conceivable form. It is tenacious within itself, and will adhere firmly to practically any surface, except a greasy one, with which it is brought into intimate contact, and dries, within a few hours, to a hardness similar to that of a piece of pear wood. There is, so far as we can see, only one drawback to plastic wood, and that is its contraction on hardening, which amounts to about 3 per cent. of its dimensions in one direction. It is noteworthy, however, that the whole of this contraction appears to take place soon after setting begins, and that there is no appreciable subsequent change. In any case the material adheres to its surroundings so firmly that it does not draw away from anything to which it is properly applied. The uses to which such a material can be put need little emphasis. It can, for instance, be used for patching up patterns and rounding off fillets, for which purposes it is specially suitable, as it does not need nailing on and is damp proof. Experiments have also shown that a stiff form of plastic wood might be used in a moulding process for making small articles, such as switch parts, &c. When it is dry, plastic wood can be worked with ordinary joiners' tools and will take nails. It is, in fact, as we have already suggested, just like a soft wood, but has not, of course, any grain.

In view of the apparent utility of the material, we recently visited Stowmarket and explored the processes of its manufacture, under the guidance of Mr. J. A. Carter, the works manager. A brief account of what we saw may add to the interest in the various products of the company. The present works comprise only a part of the factory as it was a few years ago, since a considerable area of land has been sold, but they still stretch for a good distance along one side of the river and are quite close to the station of the Great Eastern Railway. There is a standard gauge siding running right through the works. Electric power is provided by a nicely laid out plant, which includes two Belliss and Morcom 450-kilowatt and two 100-kilowatt high-speed engine-driven generators with double commutators for giving 110–220 volts. This low voltage was adopted on account of the Home Office regulations in connection with the original explosives works, but when these rules were relaxed a motor generator was put in and part of the supply is stepped up for distribution on the three-wire system at 220–440 volts. Another motor generator, belt-driven, combination has been put in for supplying a feeder with alternating current at 3300 volts, from which it is intended to provide some of the outlying villages with power in connection with the local electricity works. There are two condensing plants, both arranged above the floor level, which draw cooling water from the adjacent river. There is an old derelict lock in the river at this point, and advantage is taken of the fall thus provided to assist the circulation through the condensers. A Reavell air compressor driven by a 70 horse-power motor is placed in the station for supplying air to blow acids from one container to another and for various other services. There are also two electrically driven turbine pumps, which can be worked in parallel or in series for fire-extinguishing purposes.

Steam for the engines and for various heating services is supplied by two batteries of four Yates and Thom Lancashire boilers each. There is a tippler for tipping full-sized coal trucks, an elevator to take the coal to overhead bunkers, and a scraper conveyor for removing the ashes. The boilers are fitted with mechanical stokers, and each battery has its own induced draught fan and chimney. At the opposite end of the works there is another boiler-house, built on the same general lines, where there are three boilers for raising low-pressure steam for heating. We specially noted, not only in the power plant, but throughout the works, that every effort has been made to reduce manual labour to a minimum. The

general water supply for the works is taken from an artesian well in which the water level comes up nearly to the surface. The water is picked up by a centrifugal pump, treated in a Paterson water softener, passed through Candy filters, and delivered to a large concrete tank on the top of the nitrating building. Great care is taken to prevent the water coming into contact with iron, and all the piping is either of copper or brass. This precaution is necessary, as the least trace of iron will stain the product brown and spoil it for many purposes.

The nitrating building just referred to is the one in which the first process of manufacture is carried out. It has a reinforced concrete framework encased with brick on the outside and with brick panels between the columns. The interior walls are made as plain as possible in order to eliminate lodging places for dust, which might be shaken down and contaminate the material being manufactured. The floors are all tiled, and mats are provided at every door to check the introduction of dirt. In this connection the firm's long experience in explosive making must be of great assistance, and many of the arrangements are reminiscent of a "danger building."

The chief raw material is cotton, although paper is sometimes used as a source of cellulose. It is rather remarkable that the character of the material has a distinct effect on the physical properties of the finished product, in spite of the fact that during the process of manufacture it goes through a very precisely regulated chemical action which entirely changes its appearance. Thus cotton from one part of the world will give a product which is quite distinct from that made with cotton coming from another district. Advantage is taken of this fact to adapt the output to a variety of services.

The cotton arrives on the site in the form of bales, which are broken open on the ground floor and delivered to the top of the nitrating building. Here it is passed through a machine similar to those used in cotton mills, which opens out the fibre and removes all foreign matter. The cotton is delivered into large galvanised canisters which contain some 80 lb. each. These canisters are picked up by a runway and dropped on funnel-like stands which are supplied with warm dry air from steam-heated coils. The bottom of the canisters are perforated and the draught rising through their contents dries the moisture out of the cotton. As soon as the drying is complete, a tightly fitting lid is put on the canister and a record is made of the contents.

The cotton is taken, as required, to an adjacent room at a slightly lower level, where there is a row of nitrating pans. These appliances have much the appearance of ordinary centrifugal hydro-extractors with bronze cages and tiled outer cases. The cage is filled with a charge—one canister full—of cotton, and is slowly revolved while a mixture of strong nitric and sulphuric acids is run in from a stoneware pipe to fill the pan. A cover is then put on and the machine allowed to stand while the nitric acid attacks the cellulose. The sulphuric acid is, of course, only added for the purpose of absorbing the water produced during the action and thus maintaining the nitric acid in an undiluted state. The fumes produced are carried away by large stoneware pipes and are driven up a stack by an air ejector. When the reaction is completed the acid is run off and the centrifugal started. In this way the surplus acid is thrown out to such an extent that the charge can be handled lightly without burning the skin. The spent acid is sent to a recovery plant where the nitric is saved and the dilute sulphuric is put in containers for sale outside the works. The charge is then picked out of the centrifugal with tongs, and is dropped into an earthenware shoot alongside, down which it is washed by a stream of water.

After the nitrated cotton has been washed and passed through a machine closely resembling the washers used in paper mills, except that all the parts with which the charge may come in contact are non-ferrous, it passes on to a boiling process. The material is free from uncombined acid at this stage, but the boiling is necessary to stabilise it and prevent decomposition. The boilers take the form of large closed cylinders lined with tiles. The heating is not actually carried out in this cylinder, but in a smaller auxiliary chamber fitted with steam coils. The charge is continuously drawn off from the bottom of the large cylinder by a centrifugal pump, passed through the heater and returned to the top of the cylinder. When the boiling, which takes place at atmospheric pressure, is completed the water is drained off and the batch is allowed to cool down. A man then gets down into the cylinder and throws out the charge into an adjacent hopper. With the exception of unloading the centrifugals, which is a comparatively small matter, this emptying of the boilers is the only part of the process in which the material is man-handled, and it has not been found possible to substitute mechanical means, as the charge will not flow at all when the water is drained off.

The general appearance of the material has, so far, been changed very little—it still looks like the original cotton—but it is now passed in succession through two beating engines, like those used in paper mills, and is mashed up with water to such an extent that it becomes almost a pulp. In this stage it is readily handled by a centrifugal pump and is delivered to a large tiled vat equipped with rotary stirrers. The various batches of nitrated cellulose are collected in this vat and are blended in such proportions as will produce the desired final product.

It now becomes necessary to remove all traces of water from the material, and for this purpose it is taken to another building where it is charged into centrifugal machines. The cages of these machines have an annular space for the reception of the charge and an inner, central, space which is filled with spirit. When the centrifugal is run up to speed the spirit literally pushes out the water in front of it, and is drained away to stills, where it is freed from water for use again. A faint trace of spirit is left in the charge, but is not detrimental.

The manufacture of the nitrated cellulose is now complete, and the material is stored away in canisters for use as required.

The next step is to dissolve the material in a solvent, the character of which depends upon the ultimate product required, but it may be said that amyl acetate is one of the principal solvents used. Thus enamels, lacquers, cements, both air drying or for using hot, and the plastic wood already referred to, require different treatment.

The dissolving plant is in a separate house of three storeys. On the ground floor there are the storage tanks for the solvents. Above, there is the dissolving chamber, and on the same level a range of small centrifugal pumps, one for each solvent. These pumps raise the liquids from below and deliver them to little cisterns above, while the cisterns overflow into their tanks below again. A constant supply of solvents is thus available for running into the dissolving chamber without there ever being any great bulk in the top of the building. The canisters of nitrated cellulose are brought into the building by an overhead runway and hoisted up to the next floor. The contents are tipped into the chamber and the solvents run in. For some purposes, such as cements, the process is now complete, and the material is taken away to the packing department, but for making enamels it has to be ground with pigments, and for this purpose a bank of grinding mills has been installed. It should be mentioned that the enamels set with a beautifully glossy finish when applied with an air spray, but do not flow sufficiently freely for application with a brush.

For making plastic wood the nitrated cellulose is dissolved to form a thick syrup, and it is incorporated with finely ground wood meal in a Perkin kneading machine, which is fitted with a cover to prevent evaporation. It then only remains to pack the material in air-tight tins for dispatch.

From the foregoing account it will be gathered that over and above the plastic wood, which was the original reason for our visit to Stowmarket, the company makes a number of other materials of interest to the engineer, while the factory is a fine example of conversion from war-time to peace-time manufacture. The London offices of the company are at 62, London-wall.

An American 300,000-Kw. Power Station at a Coal Mine.

To effect the most economical use of coal in the development of power it has been suggested many times that large steam plants for the generation of electric current should be established at or near the collieries in order to save the handling and transportation of coal and to obtain the fuel at a minimum cost. Two other conditions necessary for the economic utilisation of coal in this way, however, are a large supply of water for the condensing system and an ample market for the electric current within reasonable distance. This combination of conditions is not frequently to be found near the coal mines.

An interesting example of an American power station established at a site which combines coal, water and market is at Colfax, Pennsylvania, where the Duquesne Electric Light Company, of Pittsburg, has built a new plant having a capacity of 300,000 kilowatts. This plant is on the bank of the Allegheny River, only three-quarters of a mile from a mine owned by a subsidiary company, and has the city of Pittsburg—15 miles distant—as a market for the current generated. It was designed by the Dwight P. Robinson Company, of New York, and the following description is compiled from a series of articles in the American journal *Power*, the illustrations being taken from the same journal. This new Colfax plant and the older Brunot's Island plant of 120,000 kilowatts, both owned by the Duquesne Electric Light Company, serve opposite ends of an elliptical transmission line which encloses a city and industrial district of 1154 square miles, having a population of 1,300,000. Current is transmitted at 66,000 volts and reduced at sub-stations to 22,000 and 11,000 volts for distribution.

The generating capacity of the plant was governed by the available supply of water, the minimum flow of the Allegheny River being sufficient for a plant developing 300,000 kilowatts. As this station will carry the base load of the system, it was desirable to install generating units of the largest size, with due regard to economy and reliability. There will be six units of 60,000 kilowatts each, one of these being a reserve for use when any one of the regular units is out of commission for inspection or repair. Each unit consists of three turbo-generator elements with parallel shafts 30ft. apart. The building is a rectangular structure 240ft. wide, and at present 350ft. long for two generating units and their boilers, but when completed it will be about 800ft. long, as shown in the sketch plan, Fig. 1, in which the space for future extension is shown by dotted lines. The building is divided by longitudinal partition walls into three main sections: the boiler room in the rear, 108ft. wide; the turbine and generator room, 84ft. wide; and the electrical room on the front or river side, 48ft. wide. The first unit was put in operation in December, 1920. In the drawing on page 232 is shown a typical cross section of the station.

The fuel is a semi-bituminous coal having a heat

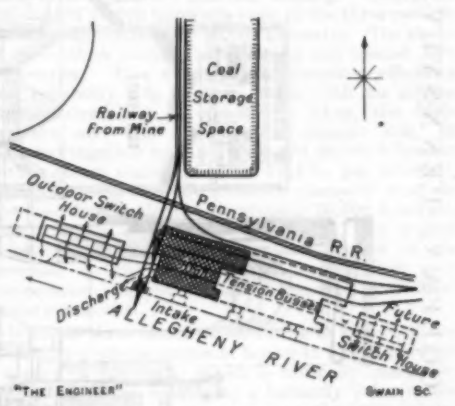


FIG. 1—SKETCH PLAN OF COLFAX POWER STATION

value of about 13,500 B.Th.U. Its proximate analysis is 54 per cent. fixed carbon, 34 per cent. volatile matter, 9 per cent. ash, and 3 per cent. moisture. This coal is brought from the mine over a private railway in ordinary standard gauge wagons, and is delivered at a stock yard 400ft. by 1000ft., spanned by a travelling gantry with a trolley hoist carrying a grab bucket. There is a normal storage capacity of 150,000 tons, but for an emergency supply this can be increased to 250,000 tons by piling the coal to a height of 40ft. Coal can be brought in also by river barges and by the Pennsylvania Railway, the latter having a main line which passes between the generating station and the coal storage yard.

Coal is discharged from the drop-bottom railway wagons into two hoppers of 150 tons capacity, placed

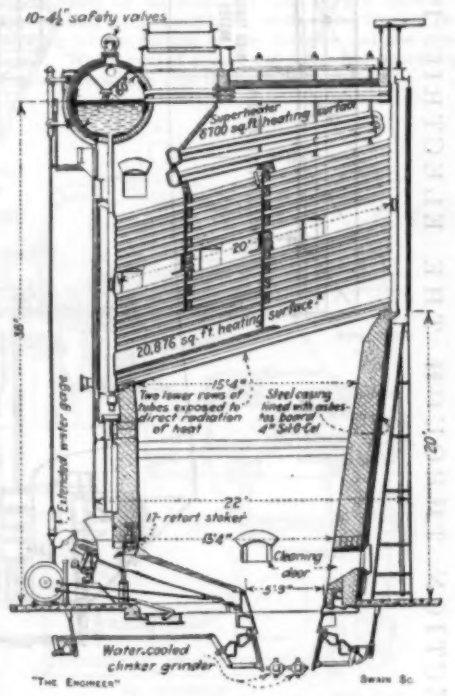
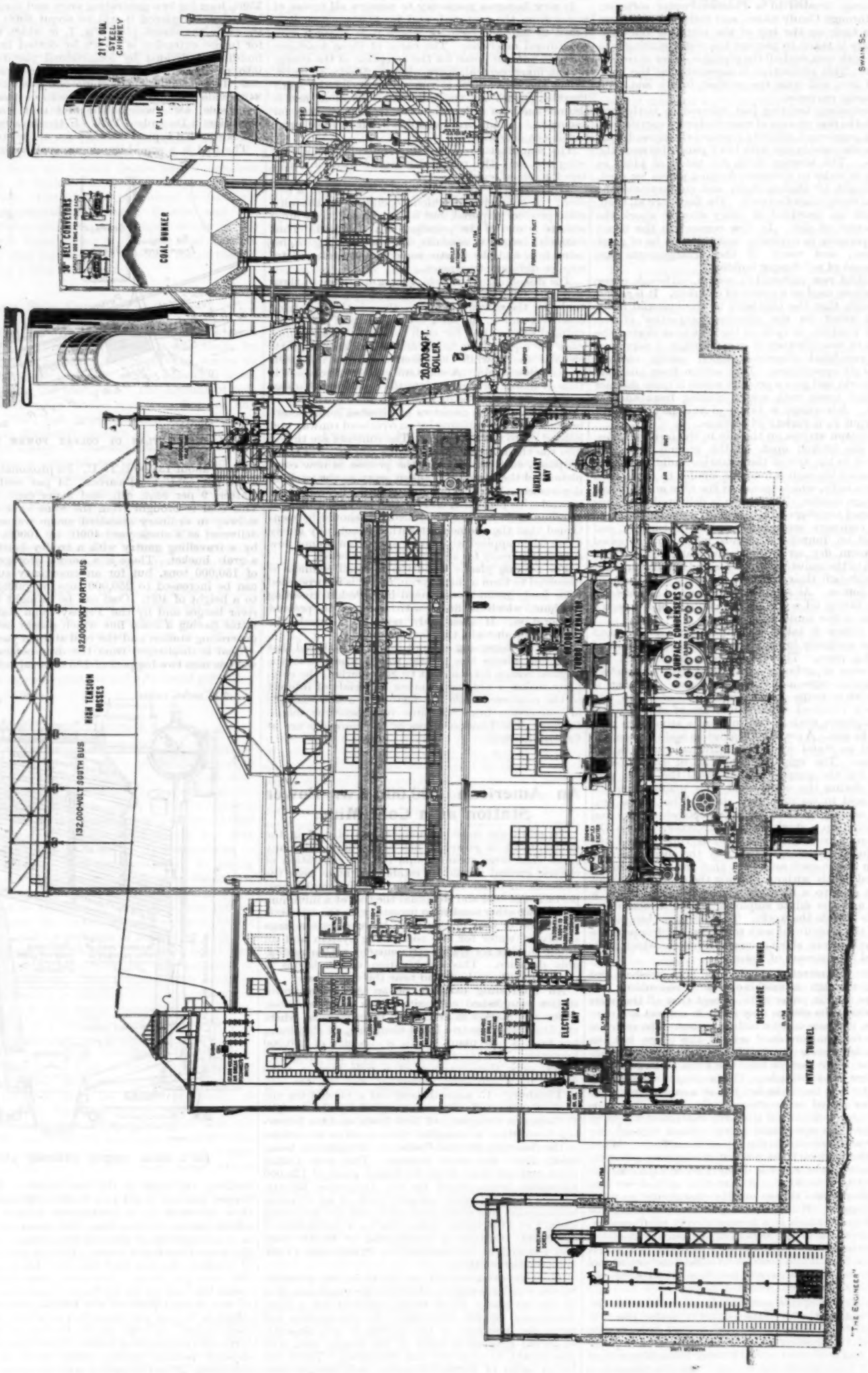


FIG. 2—CROSS SECTION THROUGH BOILER

between the rails of the coal tracks. From each hopper the coal is fed to a double-roll crusher and is then elevated by a continuous bucket conveyor, which delivers it to a 30in. belt conveyor extending over a longitudinal concrete coal bunker high above the floor of the boiler-house. Each of the two systems of crusher, elevator and conveyor has a capacity of 200 tons per hour. Automatic travelling trippers cause the coal to be discharged from the conveyors at any desired point of the bunker, the capacity of which is 10 tons per lineal foot or about 240 tons for each boiler. A ridge in the bottom of the bunker forms two longitudinal hoppers or troughs, from which depend vertical spouts fitted with gates. Two travelling 20-ton hoppers, with weighing machines and recording registers, are filled with coal at any of these spouts, and then discharge it through inclined

CROSS SECTION THROUGH THE ELECTRIC POWER STATION AT COLFAX, PENNSYLVANIA



spouts to the magazines of the automatic stokers on the boiler fronts. All the coal handling appliances are operated by electric motors. As the floor of the firing room, between the two rows of boilers, is 30ft. above the ground, the ashes are allowed to fall by gravity from the furnace ashpits into hoppers or chambers having air-operated bottom gates through which the ashes are discharged into railway wagons on two lines of rails extending through the building. In the chute through which the ashes fall from the ashpit is placed a double-roll water-cooled clinker grinder or crusher. The ash hoppers are of concrete, with fire-brick lining, and each has a capacity of 1900 cubic feet.

There are eight Babcock and Wilcox water-tube

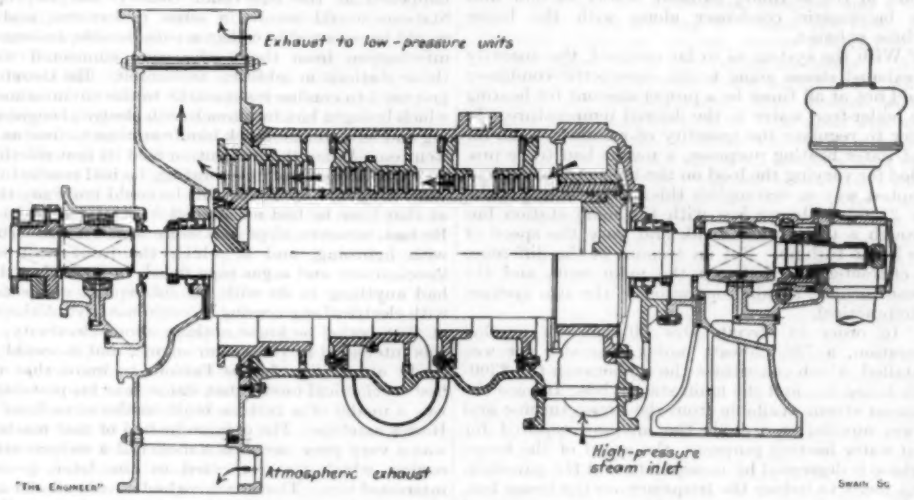


FIG. 3—HIGH-PRESSURE TURBINE

boilers for each unit, one of the boilers being held in reserve. They work under 275 lb. pressure, and with 180 deg. of superheat the total temperature of the steam is about 6000 deg. Fah. Fig. 2 is a cross section through one of the boilers. Each boiler is 51 tubes wide and 18 tubes high, occupies a floor space of 34ft. by 22ft., and has a height of 20ft. from the firing room floor to the bottom of the uptake header and 37½ft. to the steam drum, which is 5ft. in diameter. The tubes are 20ft. long, and give 20,876 square feet of heating surface, the furnace volume being 0.345 cubic foot per square foot of heating surface. The two lower rows of tubes are dropped below the others and are exposed to direct radiation of heat from the furnace, the baffle being placed over these two rows, as shown in the drawing. Above the upper bank of tubes is a pipe superheater having 6700 square feet of heating surface. Automatic stokers driven by electric motors feed the coal on to an inclined grate, the ashes falling from the end of this through the water-cooled double-roll clinker grinders mentioned above, which also are motor-driven. The back wall has an inward slope, the clear length of furnace being 15ft. 4in. at the bottom of the bank of tubes and 13ft. 4in. at the top of the inclined grate. Perforated blocks in the furnace walls admit a small amount of air to prevent the formation of clinker on the walls.

The boilers are arranged in batteries of four. Forced draught for each battery is supplied from a fan geared to a 40 horse-power turbine and having a maximum capacity of 250,000 cubic feet per minute at 65 deg. Fah. against a static pressure of 6in. of water. The fan speed is controlled in relation to the boiler pressure, while the outlet dampers to individual boilers are controlled in relation to the draught intensity over the fire, the control being automatic in each case. The air pipes are arranged to permit of any battery being served by any one of the fans of that unit. Dampers operated by hand are placed in the air pipe to each boiler. For each battery of four boilers there is a steel chimney supported on the steel roof framing of the building. These chimneys are 21ft. diameter inside the fire-brick lining, and have their tops 325ft. above the grates. The flues are connected to them at 30ft. above the roof of the building.

Safety valves set to blow off at 285 lb. gauge pressure are mounted on the 5ft. steam drums, there being ten such valves to each drum. Two 8in. pipes connect the drum with the superheater, and on the 8in. outlet from the superheater is another safety valve. The water level of the boilers is shown clearly at the firing floor by means of extended water columns on the boiler fronts. The boiler equipment includes feed-water regulators, water flow meters, draught gauges, pyrometers, CO_2 recorders and soot blowers with fixed piping. In front of each boiler is a panel having two indicating steam pressure gauges, two indicating and recording feed-water meters, an indicating draught gauge and a CO_2 recorder. A main steam header, 20in. diameter, is laid behind each row of boilers and about 4ft. above the floor, expansion and contraction movements being provided for by vertical loops. This main is connected with the boilers by 10in. pipes and with each turbo-generator unit by an 18in. pipe. All auxiliaries are motor-driven, with the exception of the turbine-operated fans and feed pumps, while the exciters can be driven by either motors or turbines, although normally the former will be used. Current for the electrically operated auxiliaries is furnished by a turbo-generator of 2000 kilowatt capacity, which works at 2300 volts. This turbine exhausts into a barometric condenser which serves as a feed-water heater.

Feed pumps are of the four-stage centrifugal type, driven by a non-condensing direct-connected steam turbine of 400 horse-power, the pumps having each a capacity of 1500 gallons per minute. The feed water needed to make up the loss resulting from drips, drains and soot blowers and from blowing down the boilers is supplied by a double-effect dry-tube evaporator taking the exhaust from the turbines of the feed pumps and forced draught fans. This evaporator has a capacity of 30,000 lb. per hour. Recording meters of the Venturi type measure both the raw water supply to the evaporator and the distillate which it discharges. The condensate water flows from head tanks on the roof to the barometric condenser, in which it is heated to 200 deg. Fah. by the exhaust from the turbines of the auxiliaries, and then flows to the boiler feed-water tank, which latter acts as the seal on the tail pipe of the condenser. With a supply of 530,000 lb. of condensing water per hour at 105 deg. Fah., the barometric condenser has a capacity of 50,000 lb. of steam per hour.

The main turbo-generators are of the Westinghouse three-cylinder cross-compound type, designed for a continuous rating of 60,000 kilowatts with steam at 265 lb. gauge pressure at the regulator and 175 deg. of superheat, or a total temperature of about 585 deg., expanding to a condenser pressure of 1in. of mercury. The steam end of the unit has a maximum capacity of 70,000 kilowatts, and the generator has the same capacity at 85 per cent. power factor without exceeding the temperature limit of the windings. When operating at the most efficient load—50,000 kilowatts—the unit will produce 1 kilowatt-hour on a steam consumption of 10.58 lb.

The steam passes first through a single-flow reaction turbine operating at 1800 revolutions, and under full load conditions half of the temperature drop occurs here. This turbine has a high-pressure rotor—Fig. 3—and has a central body or drum with heads which are secured to the shaft ends, the drum being pressed upon the heads and secured by shrink rings. The steam exhausting from this high-pressure section is carried by two overhead pipes to two low-pressure sections of semi-double-flow construction, operating at 1200 revolutions. The low-pressure rotor—Fig. 4—has a central section consisting of a drum or cylinder on which are mounted the single-flow reaction blading and labyrinth packing. The shaft ends are secured to the drum heads, each shaft carrying two discs of low-pressure reaction blading. Under the full load of 60,000 kilowatts each of the three sections develops approximately 20,000 kilowatts. The shafts of these three sections are parallel and spaced 30ft. on centres. This arrangement combines efficiency and reliability due to large units with an advantageous flexibility of operation. Thus, the high-pressure and one low-pressure element may be operated together to carry a load of 30,000 kilowatts with a steam consumption of 12.6 lb. per kilowatt-hour; or the two low-pressure elements may be operated independently, developing 30,000 kilowatts with a steam consumption of 13.8 lb. In normal operation, all steam is under the control of the governor on the high-pressure element, but each low-pressure element has also a governor and direct steam connection.

With all three elements operating as a unit, if one of the low-pressure elements begins to run at too high a speed, its governor—which is normally inactive—cuts off its steam by closing a butterfly valve in the pipe from the high-pressure element, the excess steam from the latter being released to the atmosphere by a 25in. relief valve opening at 60 lb. pressure, until the operator adjusts the loads to the new conditions. Should the automatic stop valve to the high-pressure element be closed on account of over-speed or other cause, the unit will begin to slow down, but when speed has been reduced about 3 per cent; below normal, other valves are opened automatically to admit live steam to the two low-pressure elements, which then continue to carry the load under the control of their own governors. Similar operations take place when only the high-pressure element and one low-pressure element are in service. The low-pressure elements have each two exhausts to separate condensers. As the exhaust openings are elliptical and about 9ft. by 14ft., it was considered that the ordinary type of copper expansion joint would not be sufficiently flexible. For this reason the connection is made by an elliptical tube of ¼in. moulded india-rubber, 2ft. in length, the ends being formed for clamping to the flanges of the turbine and the condenser. Water-cooled joints will keep the operating temperature within safe limits for the rubber.

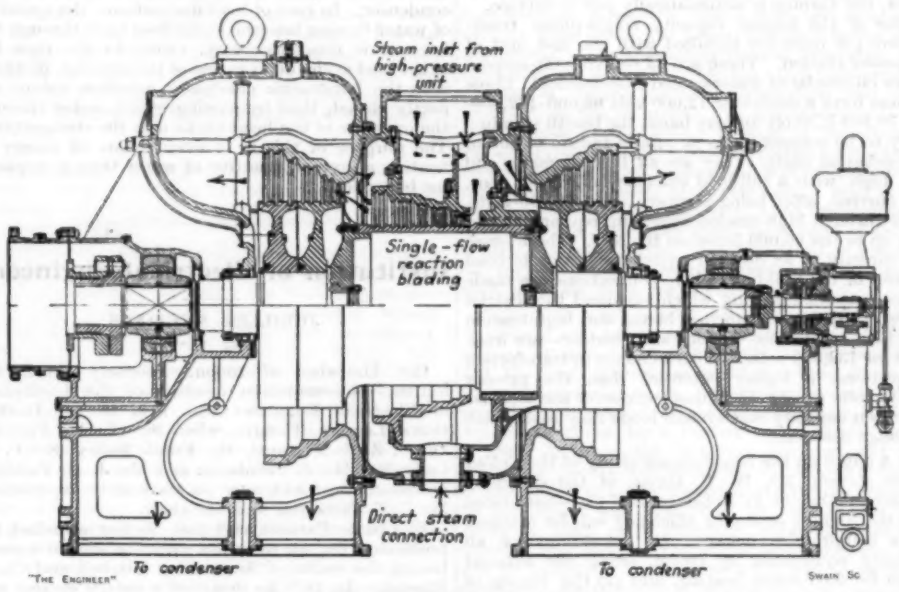


FIG. 4—LOW-PRESSURE TURBINE

Four surface condensers aggregating 100,000 square feet serve each of the turbo-generator units, the normal full load steam consumption of which is 648,000 lb. per hour. For each of the four exhausts there is a condenser having 25,000 square feet of condensing surface in 5070 tubes of Muntz metal, No. 16 U.S. gauge, the tubes being 1in. in diameter and 18ft. 10in. long between the heads. In view of the liability of dirt and *débris* in river water after storms, each condenser is so divided that half of it may be isolated for cleaning. Each battery of four condensers is served by three motor-driven centrifugal circulating pumps discharging into a common header, so that any combination of pumps may be operated. Each pump is driven by a 2200-volt induction motor of

600 horse-power and has a capacity of 44,000 gallons per minute at 480 revolutions, the suction and discharge being equivalent to diameters of 6ft. and 5ft. respectively. For handling the water of condensation there are four centrifugal two-stage pumps with a capacity of 1000 gallons per minute, and driven at 1100 revolutions by induction motors of 100 horse-power. Two pumps are sufficient with maximum load on the turbine, the others being for alternate use or to handle excessive leakage in case of burst tubes.

Owing to the varying vacuum due to changes in temperature of the circulating water, it was concluded that motor-driven hydraulic pumps in connection with a house or service turbine would require less steam consumption for air removal than if air ejectors of the steam jet type were used. The three air pumps, with a capacity of 30 cubic feet per minute, take river water from the concrete tanks beneath the basement floor and discharge into the same tanks, the water travel between discharge and suction pipes being sufficient to ensure complete air separation. It is proposed to install a rotary dry-vacuum pump in connection with an air bell for measuring the leakage. A saline-testing apparatus is used to detect any leakage of river water into the condensate or water of condensation. Recording Venturi meters measure the condensate and recording thermometers indicate the temperatures of the exhaust steam and the condensate. As the turbine room is parallel with and close to the river, it was found economical and convenient to serve each two units with a separate circulating water intake and well for revolving screens.

At the electrical end of the unit are the three 12,000-volt 60-cycle 23,600-kilovolt-ampère generating elements, connected to the three turbine elements and operated as one machine. The three elements are switched together on a common bus and given field excitation while stationary, being then brought up to normal frequency and voltage as one generator by the admission of steam to the high-pressure turbine, and finally synchronised with the 66,000-volt system through the low-tension circuit-breaker of a 75,000-kilovolt-ampère transformer bank. In the completed station it is not proposed to parallel more than the three elements of one unit on any common 12,000-volt bus. Each unit is electrically isolated from all the others. For the protection of the generator windings, arrangements are made by which an internal short-circuit will automatically disconnect the generator from the 12,000-volt bus, close the steam regulator, operate the field circuit breakers, and sound an alarm in the turbine room, besides lighting red lamps at the generator and the switchboard. Fire in the generators may be extinguished by turning high-pressure steam into the windings. The exciters are 250-volt 350-kilowatt machines driven by motor or turbine. In normal operation the exciter is motor-driven, but a small amount of live steam is admitted to the turbine. If the speed should fall through some failure of the motor, the turbine is automatically put in service.

Four of the largest capacity single-phase transformers yet built are installed with the first unit of the power station. These are 23,600-kilovolt-ampère indoor oil-insulated water-cooled transformers. Three of them form a delta-star 12,000-volt 66,000–132,000-volt 70,800-kilovolt-ampère bank, the fourth standing ready to be connected up in case of failure of one of the operating units. They are all 10ft. diameter and 22ft. high, with a full-load efficiency of 99 per cent. The current, after being stepped up to 66,000-volts, is led through high-tension switching equipment and then up to the 66,000 buses on the roof. These buses lead directly to an outdoor switching station beyond the end of the building, where connections are made to the transmission ring which surround the district served. All the transformer banks and high-tension switching equipment—indoor and outdoor—are insulated for 132,000 volts. With a change in transformer connections, a higher potential than the present 66,000 volts can be introduced whenever the increase in station capacity and system loads may make such a change desirable.

In a paper on the heat-balance study of the Colfax power station, Mr. W. P. Gavit, of the designing engineers—Dwight P. Robinson and Co.—has stated that the highest economic efficiency will be attained by a compromise between (1) the driving of all auxiliary equipment by steam, using the exhaust steam for feed-water heating, and (2) the driving of the auxiliaries by electric motors, steam for feed-water heating being extracted from the lower stages of the main unit. This economic efficiency is aimed at in the design of the station described in the foregoing. The boiler feed pumps and the forced draught fans are the only steam-driven auxiliaries. To protect the motor-driven auxiliaries from outside disturbances, a separate house bus fed by a 2000-kilowatt turbo-generator known as a "house turbine" is provided,. The exhaust steam from this turbine is condensed in a barometric condenser, using the condensate from the main unit for cooling water, this condenser acting as a boiler feed-water heater. The following is a quotation from Mr. Gavit's article in *Power*:—"On account of the lack of pure water for boiler-feed purposes, it was found necessary to install equipment for evaporating sufficient water to make up the losses in the station. This evaporator is of the Lillie dry-tube double-effect type, and is guaranteed to evaporate 1.64 lb. of water per pound of steam supplied to it. Steam for this equipment is furnished by the exhaust from the forced-draught fans and boiler-feed pumps. The condensate from the main unit is carried through the evaporator condenser before it goes to the barometric condensers. Virtually all of the heat supplied to the evaporator is retained either in the distillate or the condensate, the only losses being radiation and blow-down. It is evident that the amount of exhaust steam available from the forced-draught fans and boiler-feed pumps could not in practice be kept exactly right for the evaporator demand. In order that this excess steam would not be lost, a flow or back-pressure valve is provided, permitting any excess steam in the auxiliary exhaust header to flow into the barometric condenser along with the house turbine exhaust.

"With the system as so far outlined, the quantity of exhaust steam going to the barometric condenser could not at all times be a proper amount for heating the boiler-feed water to the desired temperature. In order to regulate the quantity of exhaust steam for feed-water heating purposes, a means had to be provided for varying the load on the house turbine. The simplest way to accomplish this would be to parallel the 2300-volt house bus with the main station bus through a transformer bank and vary the speed of the house turbine. But on account of the difference in characteristics between the main units and the house turbine, parallel operation of the two systems is impractical.

"In order to obviate this difficulty of parallel operation, a 750-kilowatt motor generator set was installed, which constitutes the tie between the 2300-volt house bus and the main station bus. In case the exhaust steam available from the house turbine and steam auxiliaries exceeds the amount required for feed-water heating purposes, the speed of the house turbine is decreased by manipulation of the governor. This tends to reduce the frequency on the house bus, and owing to the constant frequency maintained through the motor generator set, power is fed through it to the house bus, thus reducing the load on the house turbine. The quantity of steam passing through the house turbine to the barometric heater is thus reduced. The motor generator set is provided with reverse-current relays to prevent the possibility of feeding the current from the house turbine to the main bus. It will be seen that this system is capable of very close adjustment and permits the maintenance of any desired temperature of feed water. In addition to this, the injection water to the barometric condensers is controlled by remote-control valves, to meet the boiler demand.

"A thermometer is provided at the main switchboard, which shows the temperature of the water in the boiler-feed tank. The switchboard operator controls the boiler-feed temperature by a variation of the load on the house turbine and consequent variation of the amount of steam going to the barometric condenser. In case of load fluctuations, the quantity of water flowing into the boiler-feed tank through the barometric condenser may, owing to the time lag in the feed cycle, be in excess of the demand, in which case the barometric condenser injection valves are partly closed, thus by-passing excess water through the overflow of the head tanks into the storage tank. The purpose of this is to avoid waste of energy in heating a greater quantity of water than is required for boiler feed."

Institution of Electrical Engineers.

JUBILLEE MEETINGS.

No. II.*

On Thursday afternoon, February 23rd, the fourth commemoration meeting of the Institution of Electrical Engineers was held in the Institution's Lecture Theatre, when Sir Charles Parsons, Dr. S. Z. de Ferranti, Mr. Frank Bailey, Sir T. O. Callender, Mr. J. Swinburn, and Mr. J. H. Patchell, delivered short addresses on their early experiences. Mr. C. T. Patterson took the chair.

Sir Charles Parsons said that he first attacked the problem of driving dynamos whilst he was an apprentice in the works of Armstrong, Mitchell and Co. at Elswick. In 1877 he designed a rotary engine, and forty engines of that type were built. It was not until 1884, however, that he set to work on the design of steam turbines and dynamos which could be driven by them. The first turbo-generator set which he built worked at 18,000 revolutions per minute and the armature of the dynamo was less than 3in. in diameter. Whilst the steam consumption was about fifteen times greater than that of a modern turbo-generator set, the performance of the machine was otherwise quite satisfactory. Many similar machines were subsequently built and put into use, but mainly on board ships, including Atlantic liners and warships. The steam consumption of those units was far superior to that of the original turbine. In 1887 ten turbo-generator sets were used to light the Newcastle Exhibition with "Sunbeam" incandescent lamps made at Gateshead-on-Tyne. In the following year the first alternating-current turbo-generator was built. Four of these machines were subsequently supplied to the Newcastle and District Electric Lighting Company, whilst a few years later a set of 120 kilowatts capacity was built for the Cambridge Electric Supply Company. At that period the steam consumption had been reduced to 27 lb. per Board of Trade unit. In 1899 two turbo-alternators rated at 1000 kilowatts were ordered by the Corporation of Elberfeld, Germany, and tests made on those machines showed that the consumption was 18½ lb. per unit. From that time the size of his turbo-generating machines steadily increased, until in 1911 it reached 25,000 kilowatts.

Dr. Ferranti said that a full account of what happened at the Grosvenor Gallery and Deptford Stations would involve a series of lectures, and it would be essential to collect a considerable amount of information from those who were connected with those stations in addition to himself. He therefore proposed to confine his remarks to the circumstances which brought him into touch with electrical engineering and how things struck him from time to time as he went on. When the Institution held its first meeting, which they were commemorating, he had reached the year of eight, and he thought he could truly say that at that time he had no interest in electrical matters. He had, however, slept in a house whilst it was struck with lightning, and of which the front wall was knocked out and a gas pipe fused, but whether that had anything to do with his subsequent connection with electrical engineering he could not say. Although at that period he knew nothing about electricity, he was interested in the steam engine, and it would no doubt amuse Sir Charles Parsons to know that the first mechanical model that came into his possession was a model of a turbine built on the same lines as Hero's machine. The opinion he had of that machine was a very poor one, but a model of a reciprocating engine, which was presented to him later, greatly interested him. That machine had a real cylinder and piston and went backwards and forwards as well as going round. It was not until he reached the age of eleven that he became interested in electricity. At that time his parents presented him with a book entitled "The Playbook of Science," which was written by Professor Pepper, of Polytechnic fame. Later he obtained Ganot's Physics, and from those two books he got most of his early technical knowledge. It was very hard in those days for any ordinary person to get any information on electrical subjects. At one time, for example, he conceived the idea of constructing a magnetic engine which would work by the attraction or repulsion of permanent magnets, and the operation of the machine involved the insulation of magnetism. He could not, however, find anyone who could help him in the matter, and after a long search for a suitable material he finally came to London and called upon an optician in Hatton Garden. The optician was, however, quite unable to name a suitable material, and after a good deal of discussion he asked the man whether he thought brass would do, and he said that it would. Not long afterwards he made a good deal of progress in his electrical work and succeeded in constructing bichromate cells and an arc lamp. A little later he was fortunate enough to find a man who had made a dynamo with a shuttle Siemens armature and a two-part commutator. That machine made a great impression upon him and he decided to improve upon it. He knew about the Gramme machine, although he had never seen it; but he did not know about the Pacinotti dynamo. The machine which he ultimately produced, however, was to all intents and purposes the same as that designed by Pacinotti, and it worked very well. He was greatly impressed by what he saw in the way of electric lighting on the Thames Embankment, although he was never able to inspect the machines which produced the result. Ultimately he went to the University College, where he had some excellent teachers; but he was afraid he learnt very little, for he was wanting all the time to be doing something of a practical nature in the electrical industry itself. After several fruitless attempts he finally succeeded in getting into Siemens' works, where he was surrounded by dynamos, and he then became happy and contented. In those days there were many electrical installations which consisted of a single dynamo supplying a single lamp, but there were also Brush machines which worked as many as sixteen lamps in series. Mr. Ferranti then referred very briefly to the circumstances which led to his association with the Deptford station, and paid tribute to a number of engineers who were associated with him in his work.

Mr. Frank Bailey, the chief engineer of the City of London Electric Lighting Company, recalled how in 1883 Sir Daniel Gooch, the chairman of the Telegraph Construction and Maintenance Company, and also of the Great Western Railway Company, arranged a contract for the lighting of the railway from Westbourne Park to Paddington Station in accordance with a scheme designed by the late Mr. J. E. H. Gordon. That successful undertaking, Mr. Bailey said, had a powerful influence on electric lighting. The engines installed at Paddington were the last built by the old and celebrated firm of J. and G. Rennie, which was among the last of the important engine-building firms within the London district. At the Whitehall elec-

* No. I. appeared February 24th.

tricity works, which were erected in 1887, the exhaust steam from the engines was used for heating water which was supplied to one hundred houses and flats in the neighbourhood for heating purposes, a system which had been copied and developed on a large scale in the United States. Continuing, Mr. Bailey referred to Major Marindin's report made to the Board of Trade in 1889, a report which, in the speaker's opinion, was at the root of the present chaotic state of the London electricity supply at the present time, for it recommended parochial control of the industry and led to the erection of small electricity works in unsuitable positions and to the subdivision of the area among a great number of companies and local authorities. The nuisance arising from the noise and vibration of heavy engines erected in the midst of residential or commercial areas, with the resulting litigation, compelled power station engineers to utilise the silent and vibrationless steam turbine. A departure from the parochial system was made in 1897, when the erection of works at Willesden was commenced and the largest engines and generators then available were placed on a site where nuisance would not count.

Sir Thomas O. Callender first of all referred to early examples of ship lighting and then to the pioneer house lighting systems with which he was connected. In 1883, he said, he did a lot of work for the Jablochkoff Company at Covent Garden, and in connection with the preliminary lighting of part of the Embankment. The first real business his firm did in this country was for the Chelsea Electricity Supply Company, which was the first company seriously to enter into the business of supplying electric light on what might be said to be orthodox lines, with the necessary Provisional Order and all the other nuisances imposed by the Government. Having got the Provisional Order, the main difficulty the company had to grapple with was that of getting money, as no one seemed to be inclined to back the undertaking with hard cash. Nevertheless, that station at Chelsea had undoubtedly a great effect in helping the electric supply industry in this country. Prior to that he had done some very interesting work for the company to which Mr. Frank Bailey had referred, namely, the Whitehall Court Company. They ran mains round and about Charing Cross and the Strand, but they had no right to do so, as they had no powers or permission. They were simply told that they had to do the work somehow and they did it. They acted as pirates and went and pulled up the roads without proper authority. No end of people wanted to know what was being done, but those in charge of the work had strict instructions to give no information. An engineer he had in charge of cable-laying was an exceedingly discreet young man and always had a plausible story to tell. The result was that no one knew what was actually going on. One day, when they were in the middle of some work in front of the National Gallery, Sir William Preece, who was then Mr. Preece, sent a message saying that he would like to see him. When he arrived Mr. Preece said that he had observed that some Callender cables were being laid outside the National Gallery, and he greatly admired the cleverness of the young man who was in charge of the job, but he wished that he—Sir Thomas Callender—would tell him to stop leading people to suppose that the work was being done for the Post Office. In those days they laid many miles of cables that really they had no right to lay, and they were seldom challenged. It was, of course, necessary to obtain permission from the local authorities, but as their permission was frequently refused they adopted the practice of simply setting about the job. He remembered on one occasion that the company which was now the Charing Cross Company wanted to lay some mains over Waterloo Bridge, and after giving careful consideration to the procedure to adopt it was decided that the best thing to do was to start on the work on the Saturday before a Bank Holiday, because the courts would then be closed and no one could get an injunction. Accordingly they got all the equipment in readiness and collected together about 300 men, and at three o'clock on Saturday afternoon they started operations on the bridge. On August Bank Holiday some person from one of the local authorities came down to find out what was being done, but no one on the job had the slightest conception of the true nature of the work upon which he was engaged. The only information the representative of the local authority could obtain was that the job was going ahead. On Tuesday morning the south end of the cables were inside Gatti's works on the other side of the bridge and the paving had been replaced. Questions subsequently arose as to what the authorities were going to do and many threatening letters were received, but ultimately the matter was dropped. Some years afterwards the Charing Cross Company regularised its position and obtained the necessary Provisional Order, but the mains which the company then scheduled had as a matter of fact been laid and had been in use for a good many years.

Mr. James Swinburne first referred to the time, namely, the year 1881, when each arc lamp usually required a separate dynamo to feed it. In December, 1881, he said he went to Antwerp with Mr. C. F. Proctor, to make some Swan lamps to prove the working of the Belgian patent, facilities being given by the owner of a wood saw-mill. They made one lamp at a cost of nearly £100. The proprietor of the saw-mill asked them to light his house. Plain copper wire, stapled to the woodwork of the mill buildings, was led from the dynamo to the house. As the owner of the house did not want his plaster walls injured, small tinned tacks were driven in the walls, and silk covered wires were twisted round them at convenient intervals. When the installation was started trouble was experienced. The speed of the dynamo varied enormously with the saw-mill load, and the wires were short-circuited promiscuously where they were wound round the tacks. The latter trouble was overcome by using two sets of tacks, one for each pole, but the dynamo speed problem remained unsolved. From Antwerp he went to Paris, to start a Swan lamp works, and met with many difficulties. He well remembered buying an engine. At the time the French did not understand cheques, and a man came with a leather bag to collect the cash, and presented a written request, which stated that he should "upset the money among his hands." After a few days he was invited to the engine-room, where he found the engine covered with flowers, and a bouquet was presented to him. The men, who were in holiday garb, had to drink the engine's health, and then close down for the day. Looking back over the last forty years, Mr. Swinburne said one's main reflection was that the giants of old were really rather pigmie. At the present time there was an industry employing thousands of trained minds, and a large number of scientific and business men of exceptional ability; and they handled money by the million. It was, therefore, exceedingly difficult to rise to the top. Forty years ago, the electricians were largely telegraph people whose equipment was not suitable for developing a new industry, science masters, and inventive enthusiasts with rather little knowledge. In those days it was fairly easy to rise high in the profession, and having done so, to maintain a reputation in spite of the growth of a large profession of highly trained younger men. Many of the older men had, however, kept in the front rank in some branch of industry or science, and would have risen to their present positions even if they had started later.

Mr. Patchell brought the afternoon meeting to a close with a brief outline of his early experiences, but he has also written a short essay on storage batteries, which presumably is what will be published in the special commemoration number of the *Journal* of the Institution of Electrical Engineers. Storage batteries, Mr. Patchell explains in his written contribution, were invented by Gaston Planté in 1860, and the cells came into use on a small scale about the time the Institution of Electrical Engineers was formed. Sir William Thomson gave the accumulator a great stimulus by publishing a letter in *The Times* of June 8th, 1881, describing a battery which he had received from Faure. Unfortunately, however, as Mr. Patchell went on to state the early storage batteries, were subject to a variety of ailments, and had a short life. But in the hands of the Electrical Power Storage Company, which was formed in 1882, storage cells were continuously improved, and ultimately came into extended use, not only for electric light, but also for propelling motor launches and tramcars. Storage batteries were first used in submarines in 1886, and the batteries employed for this purpose nowadays comprise as many as 300 cells, weighing over 200 tons.

On Thursday evening the discourses were continued. After reading a communication from the President, the Chairman then called upon Mr. J. E. Kingsbury to speak.

Everyone, Mr. Kingsbury said, was so accustomed to talking through a telephone that it required a good deal of imagination to realise the curious sensation which was experienced when receiving speech on that instrument when it was first introduced. When he first used the telephone, which was employed for communication between Lombard-street and Princes'-street, he could, he said, hardly resist some scepticism. He had left his friend at Lombard-street, yet there was the voice by his side. A feeling almost of awe overcame him. In 1878 the telephone was first used in exchange service. At the present time there were about twenty-one million telephones connected to various exchanges throughout the world. In their first business circular issued in 1877 Bell and his associates stated that they were "prepared to furnish telephones for the transmission of articulate speech through instruments not more than twenty miles apart," but in these days conversation could be accomplished over a distance of five thousand miles. The continent of America from east to west was spanned by the telephone more than seven years ago. Given commercial conditions to justify the cost, the American continent from north to south might equally be spanned, and no further invention was necessary for the accomplishment of that result. An Indo-European telephone was scientifically possible, though perhaps not commercially probable. Turning to the effect of legislation on early telephone development, Mr. Kingsbury showed that the nation regarded the telephones from the first much as a jealous shopkeeper might regard a new rival. The Government owned the telegraphs and it looked upon the telephone as a competitor.

Speaking of the early days and the origin of the London Electric Supply Corporation, Mr. G. W. Partridge explained how the late Earl of Crawford was appointed by the Government to visit the Paris Exhibition in 1882. On his return to London he and Sir Coutts Lindsey decided to install a portable electric light plant in a yard behind the Grosvenor Gallery, and as a result of that small undertaking the Sir Coutts Lindsey Company was ultimately formed. The system adopted was the series alternating-current system as invented by Goulard and Gibbs, and the current was supplied by Siemens' machines to an overhead system of mains at pressures which depended upon the load. In consequence of the effects of the currents upon neighbouring telephones the arrangement of the conductors had to be altered and arranged side by side so that the currents in the two mains neutralised one another. When, however, Dr. Ferranti became chief engineer to the London Electric Corporation he adopted what was then known as the parallel system of transformers, and that important departure eventually revolutionised the whole electric generating and transmitting system of the world. The London Electric Corporation was formed in 1887 with a capital of £1,000,000, and the Deptford station was started soon afterwards. All the electrical experts of the time, including Mr. Edison, severely criticised the scheme. Nevertheless, the Deptford station started running early in 1890 and continued to run at various pressures and under different conditions. On November 15th, 1890, however, the original Grosvenor station was burnt down. About three weeks after this event an attempt was made to run the Deptford station on the old overhead system, but as happened when a previous attempt was made to do this, the transformers burnt out and the whole system had to be completely shut down for a period of four months, and during that time the underground concentric cable system was installed. The first underground concentric cable was worked at 2400 volts, and it was laid in the Strand in September, 1890. Numerous breakdowns and difficulties were experienced in connection with the transmission of current at a pressure of 10,000 volts from Deptford to London, but under Dr. Ferranti's guidance the staff of the company ultimately manufactured its own cables, which were of the concentric type and were composed of inner and outer tubes with half an inch of brown paper between them, the paper being impregnated with ozokerite wax. The cables were made in 20ft. lengths and about 28 miles were laid, necessitating no fewer than 7000 joints. In the first instance the mains were run for a considerable distance on the walls and arches of the South-Eastern Railway, but finally the whole of the cables were laid underground. At the present time there were about 14 miles of this cable still in daily use.

Few people, Mr. Partridge continued, fully appreciated the important discoveries that were made as a result of the establishment of the Deptford station. Briefly, the following fundamental principles of modern electricity supply were established:—(1) Transformers were connected in parallel; (2) high-pressure concentric cables with one conductor earthed were used; (3) paper-insulated cables were constructed; (4) alternating-current generating stations were run in parallel; (5) the extra high-pressure system of generation and distribution was established; (6) the oil switch was introduced; (7) the phenomenon of the ageing of iron in transformers was observed; and (8) numerous methods were introduced for the control, generation, and distribution of currents at a pressure of 10,000 volts. Had it not been for the financial support of Lord Crawford and Lord Wantage, who both found large sums of money to back the brains of Dr. Ferranti and his co-workers, the high-pressure alternating-current system would have been set back for many years.

Parliament was induced in 1882 to give leave to private companies to open up streets for the purpose of laying mains, but only on the condition that the local authorities could purchase the companies' undertakings in twenty-one years. That proved so unsatisfactory that it completely held up private enterprise for a further period of six years. In 1888, however, the Act was amended and the companies' tenure was increased to forty-two years. As association or actual electrical connection between the companies was prohibited by law, it was not surprising that each company adopted whatever system it thought best for its particular district, and paid no attention whatever to what was being done elsewhere. Matters were allowed to drift on from year to year. Twenty years later, however, the 1908 Act, which permitted the companies to assist one another and supply railways, was passed. The difficulties experienced in the meantime, however, could not be exaggerated. As an example of these difficulties Mr. Partridge mentioned that the London Electric Supply Corporation risked its capital in 1906 in order to install the plant necessary for the supply of current to the Brighton Railway, although it had no legal power to supply out of its area. Taking into consideration the extraordinary pioneering work carried by the London electric supply companies, it was, Mr. Partridge thought, a great hardship that this country as a whole had not benefited more than it had done as the result of that work. During the time the pioneer work was being done other countries looked on, but as soon as they saw the advantages of the high-tension alternating-current system of generation

and distribution elaborated at Deptford they were not long in adopting it.

Mr. Bernard Drake thought that it was difficult for young electrical engineers to appreciate the condition of affairs that existed in the early days of the electrical industry. What knowledge existed when he was a young man was often retained as a secret, with the result that many were thrust into positions of responsibility with little but common sense to guide them and no books of any practical value. After obtaining a general knowledge of how the Brush dynamo was made and of how arc lamps were adjusted, and having had some experiences at the exhibition at the Crystal Palace and other places, he was suddenly sent for and asked if he thought he could take charge of some men to work the Brush Spanish patents in Madrid. He accepted the offer at once. Together with some assistants, he set out with the parts of a machine and a lamp ready for assembling and had an amusing experience with the Custom House people on the border. They made out a bill, and as he did not know their coinage he held out a handful of money and let them help themselves. Just as the train was starting the Customs people returned in a fury and tried to pull him out of the train, and a Spaniard who could talk English explained that he was accused of smuggling. They had found that the coil of "rope" on which no duty had been charged contained copper hidden inside. Explanations and a few pesetas enabled the party to retain their coil of insulated cable and to proceed on their journey. With help of his little group of assistants he erected a demonstration plant at the Buen Retiro public gardens. The fixing of the semi-portable engine and boiler and the dynamo presented no difficulties, but the cable part of the job called for much consideration. A part of the circuit actually had to consist of iron hurdles suspended from the trees. That was regarded as part of the Brush system and greatly puzzled the Germans, who were struggling to get an installation to work before the Brush job was completed. However, by working through the hot period of the day when everyone rested and at night, his men managed to beat the Germans, although they had a good start, and in due course the lamps were switched on. The late King of Spain came to see the display and congratuated him and his assistants on showing the first electric lights in Madrid. After the light had been in use for some time a Spaniard appeared on the scene, and, on the strength of legal acquisition, wished prematurely to take over the working, but as the Brush Company objected until the company was formed, he was placed in a difficult position. They tried to hustle matters, but he pocketed a brush off the commutator and awaited events. This caused much excitement and turmoil, the Spaniard maintaining that he should go to prison for theft, and that when he came out he would have to fight a duel with him. Soon after he went on to Lisbon with orders to put in order a theatre plant which had broken down. Later he was appointed managing engineer to the Brush Midland Company and the Great Western Brush Company, where he was made responsible for the early lighting stations at Bristol and Cardiff. After a holiday in America he came back with an offer for the sole agency for the B.T.H. system in Great Britain. Shortly afterwards he was offered the position of managing engineer to the Electrical Power Storage Company. He found nearly all the batteries sent out failed in a few months, and none knew why, so he persuaded the company to stop manufacture until investigation could be made. There were many theories concerning the cause of the troubles met with in connection with accumulator plates, but it was ultimately thought that those troubles might be due to the manner in which the cells were charged, and after issuing new working instructions the operation of the accumulators greatly improved. For some time he was director of Edison Accumulators, and used a considerable number of nickel-iron cells for traction work and a few for yacht lighting. Looking back on over forty years of hard work, he could not but feel that, to the pioneers, the electrical industry had not proved a gold mine, and that they would have made more money if they had taken up, say, soap manufacture. It would not, however, have been so interesting a life, and he hoped that the next generation might benefit by the spade work of those who have preceded them.

Sir William Noble, the chief engineer to the Post Office, first of all mentioned that up to 1870 several telegraph companies were in operation. Since that date, he said, the development of telegraphy in all its branches has been most striking, and furnished a strong case against those who contend that a State monopoly must necessarily retard progress. Vast changes and improvements had been made, one of the earliest being the displacement of the single needle by the sounder on important telephone lines. Duplex working was introduced in 1873 and quadruplex working soon after 1876. In 1880 the Post Office had 173 complete circuits working on the Wheatstone automatic system, and the speed reached was 400 words per minute. The Hughes printing telegraph was first used by the Post Office about 1889, when the Submarine Telegraph Company's system was acquired. Multiplex telegraphy, as first suggested in 1852 by Farmer, was destined to revolutionise telegraph practice. The first multiplex system used by the Post Office was that invented by Delany in 1884, six operators being able to work simultaneously and subsequent improvements raised that number to eight. But the Delany system required a high line speed and eventually it was abandoned. The successful duplexing of the Baudot system revolutionised telegraphy, and with one circuit 800 messages an hour had been carried between London and Birmingham. One of the greatest triumphs of the Post Office telegraph engineers was the multiple intercommunication switch, invented by Mr. T. F. Purves. It greatly expedited communication between any two outlying districts and saved the transmission of some 50,000 messages daily through the Central Exchange. It had always been the practice of the Post Office to give inventors every possible encouragement, and there was no doubt that that policy had been fully justified, as was indicated by the development of the Creed, Gell and Murray apparatus. The Creed apparatus was an adjunct to the Wheatstone system and avoided the delay and cost of translating the printed dot and dash of the Morse code. It had proved to be economical and expeditious. Murray originally devoted his attention to an automatic system on Wheatstone lines, but used a 5-unit code and page-printers for the received message. In 1898, Gulstad, of Copenhagen, invented a modified form of polarised relay known as a "vibrating relay," and its use had enabled much greater speeds of working to be obtained on underground lines, and on submarine cables, resulting in some cases in the release of "repeaters," which were costly to instal and maintain. The original instrument was arranged for simplex or for bridge duplex working. The Post Office engineers had modified that relay and had made it suitable for differential duplex circuits with very satisfactory results.

Mr. C. H. Wordingham dealt mainly with the work of Dr. John Hopkinson, under whom Mr. Wordingham served as a pupil. It was Hopkinson, he said, who first made the astonishing prediction that alternating-current machines could be run in parallel, and that prediction was verified in practice by Professor Grylls Adams at the South Foreland, where there were some lighthouse machines. The paper which Dr. Hopkinson wrote in conjunction with his brother, Dr. Edward Hopkinson, on "Dynamo Electric Machinery," probably constituted the foundation of scientific dynamo design. Another epoch-making contribution made by Dr. Hopkinson was his inaugural address to the Junior Institution, in which he laid down the principles governing the cost of production and the principles which should control the method of charging for the supply of electrical energy. In spite of the enormous amount of discussion which had since taken place on that complex subject, very little had been really added to Dr. Hopkinson's work. On his (the speaker's) articles with Dr. Hopkinson expiring, he left him for a time, but he rejoined him again in 1892, in order to supervise on his behalf the erection of the Manchester and Whitehaven generating stations. Those undertakings attracted a very large amount of attention at the time on account of the use of the five-wire system, which split up the distribution voltage into four parts, but it was doubtful if Hopkinson ever realised the credit that was due to him for the bold step which he took, or the very real success which attended it. In those days the battle of the systems was in full swing. Coming to the London Electric Supply Company, Mr. Wordingham said that he well remembered the introduction of meters by that company. At the time he joined its staff, namely, in 1889, there were one, two, or three dozen experimental meters in use. He also had a very vivid recollection of Ferranti amid the ruins of the Grosvenor Gallery station on the morning succeeding the fire. Before the day was over he had invented a safety device for the purpose of making a similar disaster impossible. Returning to Dr. Hopkinson, Mr. Wordingham said that it was a wonderful education and privilege to work with him. He was extremely large-minded, and whilst he expected a large measure of hard work from his staff, he was agreeable to work with and was always reasonable.

The Chairman, Mr. Campbell Swinton, was also intended to speak on his experiences at this meeting, but owing to the fact that all the time was taken up by the other speakers, he was unfortunately unable to do so. He has, however, kindly sent us his notes, and the following is a brief abstract of them :—When the speaking telephone was invented by a Scotsman (Alexander Graham Bell) and the microphone by a Londoner (David Hughes), enormous interest was excited in the public mind, equalled only by the discovery of the X-rays in 1896. Neither of those great inventors was an electrician, or even endowed with a scientific education. Bell was a teacher of the deaf and dumb, Hughes a professor of music, whilst Edison was a railway newsboy, and Hunnings, the original inventor of the telephone transmitters now in universal use, was a clergyman of the Church of England. Hughes was a remarkable inventor in other fields. The note-books which his widow recently bequeathed to the British Museum and Mr. Swinton was asked to examine, reveal the fact that during the year 1879–1880 Hughes made numerous and successful experiments in the transmission of signals by an elementary form of wireless telegraphy, and evidently received signals over considerable distances. This took place long before either Lodge or Marconi had entered the field, and before even the existence of electro-magnetic waves had been discovered by Hertz. Hughes, however, naturally did not know that he was dealing with such waves, and attributed his remarkable results to electrical conduction of some sort through the air. Unfortunately, he was disheartened by the criticism of brother scientists, and discontinued his experiments, otherwise we might have had wireless telegraphy some sixteen years sooner. It is clear from his note-books that during the year 1879–80 Hughes made numerous and successful experiments in the transmission of signals across space by means of the radiation given off by what he called the extra current from a small spark coil. For reception he used a Bell telephone and battery connected in a separate receiving circuit, including sometimes a microphone, which apparently acted as a coherer, or sometimes a very delicate thermo-couple, which seems to have played the part of rectifier. He began with transmissions across his sitting-room, then from one room to another in his residence, then from the latter down the street, along which he walked with the apparatus in his pockets and the telephone to his ear. He evidently received signals over considerable distances, and even tried the effect over half a mile, though in this case he obtained no very definite results. He sometimes earthed one or both ends of his transmitting and receiving circuits, thereby getting enhanced effects. He notes with evident surprise that the addition of an iron core to his extra-current coil, which increased the visual intensity of the spark, instead of increasing the strength of the transmission, as he expected, stopped it completely, owing, no doubt, to the core diminishing the frequency of oscillation below what was requisite. It must be remembered that this was long before either Lodge's or Marconi's experiments, and, indeed, some eight or nine years before Hertz's memorable discoveries. Hughes seems to have had no conception that he was dealing with electro-magnetic waves. He was, however, very sure that his effects were not due to ordinary electro-magnetic induction, and seems to have thought that they were to be explained by electric conduction through air, expressing astonishment that the results could be obtained through so great a resistance. The Paris Electrical Exhibition of 1881 gave a great impetus to electric lighting. Many British inventions were shown there, and Sir William Crookes came back so enthusiastic that he wired his house in London with his own hands, with wires drawn through glass tubes. He even made his own incandescent lamps, and installed a dynamo in the basement, driven by a gas engine. This was the first house in London permanently lighted by electricity. The first instance of electric lighting by water power was at Cragside, in 1882, where Lord Armstrong transmitted electricity by overhead wires from a waterfall to his house over a distance of 1500 yards.

Mr. Ll. B. Atkinson brought the meeting to a close in a delightful way. He said that the pleasure they had all derived from listening to Dr. Fleming's lecture, and the reminiscences of pioneer electricians, and from seeing and touching the original pieces of apparatus used by Faraday, had, he felt sure, been immense. They had seen and touched the coils, the wire, the tape and the paraffin wax, in fact, all the raw materials used by the early electricians, with, he might almost say, a certain degree of reverence. It was well that on the fiftieth anniversary of the first meeting of their Institution they should visualise a picture of the past, because he believed that we were at the beginning of a new age—a tremendous era—when the atom and its energy would replace all the generating appliances they had seen. After Mr. Atkinson had given a brief account of his early career, the meeting was declared at an end.

The Institution of Locomotive Engineers.—The annual dinner of the Institution of Locomotive Engineers was held at the Engineers' Club on the evening of Thursday, the 24th prox. The chair was taken by the President, Colonel Kitson Clark, who was supported by Dr. Hele-Shaw (President of the Institution of Mechanical Engineers), Sir Henry Thornton, Mr. Arthur Watson, Sir Henry Fowler, Sir Alexander Richardson, Sir Philip Nash, Mr. George Hughes, and Mr. R. H. Whitelegg. The toast of "The Guests" was proposed by Sir Henry Fowler, who referred to the fact that there were two general managers of railways present and both were engineers. Sir Henry Thornton, in reply, said they belonged to a highly honoured profession —transportation—which held a record for work during the war better than that of any country. In the uncertainties of the future locomotive running would play the most important part, and the general managers relied on the locomotive superintendents to help them. Mr. Arthur Watson, who also responded, observed that the main factor in railway expenditure was the locomotive hour. He found great pleasure in being associated that night with such an important body of men, seeing the part they take in railway working. On the proposal of the President, Sir Henry Thornton and Mr. Watson were elected honorary members of the Institution. Mr. R. H. Whitelegg proposed "The Technical Press," to which Sir Alexander Richardson replied, and said the technical Press might be regarded as the clearing-house of technical thought which gave out to technical men information as to what had been done. No one could afford to ignore that Press, and he begged his hearers to be liberal in their contributions to technical journals. Dr. Hele-Shaw gave the toast of "The Institution of Locomotive Engineers," and said that it had built up a membership of 1300 in ten years. Colonel Kitson Clark, in responding, said that the Institution consisted of the designers, manufacturers and users of locomotives. He commended attention to the improvement in the design of that general jobbing locomotive, the good old six-wheeled coupled goods engine.

A Seven-Day Journal.

Crisis in Shipbuilding Industry.

EMPLOYERS engaged in the shipbuilding industry feel that they have been compelled, as in the case of the engineering trades, to take a firm stand against the policy of labour. The shipbuilding deadlock turns on the question whether the war bonus is to be continued. The ballot of workers has recorded a large majority against the proposed cut of 16s. 6d. of the war bonus of 26s. 6d. on March 15th, but it is a significant illustration of the apathy of the workers to a question which threatens to deprive them of their means of living that 66 per cent. of the men entitled to vote refrained from taking part in the ballot. The unions have asked for a Court of Inquiry under the Industrial Courts Act, not only into the wages question, but into the general economic position of the industry. In refusing this request and adhering to their intention to make the cut in the bonus announced for March 15th, the employers, in an official statement, have intimated that they regard the outlook in the industry as hopeless upon its present wage costs, but are prepared to concede a period of wages stabilisation when the war bonus is discontinued. They point out to the unions that the industry has been practically at a standstill for many months, and that there is no immediate prospect of any recovery. Only 25 per cent. of the berths in the country have work proceeding on them, and in many of the principal trades in the industry unemployment is over 60 per cent. Many shipyards and ship-repairing establishments are already closed for want of work, and it is only a question of time until the closing becomes quite general.

Civil Aviation Advisory Board.

THE Board which it was announced at the recent Air Conference would be set up by the Ministry to consider the general situation of commercial aviation has now been constituted. The terms of reference suggest that it will be a permanent body having imposed upon it the duty from time to time of advising the Secretary of State on specific points. Satisfaction will be felt with the composition of the Board, which includes, in addition to Lord Gorell, Sir Frederick Sykes and Sir W. G. H. Salmond, who are members in their official capacities, representatives of the Post Office, Air League, Association of British Chambers of Commerce, Federation of British Industries, Lloyds, Royal Aeronautical Society, and the Society of British Aircraft Constructors. This gives the necessary blend of designers, manufacturers, users and Government officials. The presence of State representatives is necessary, if only for the reason that the development of civil aviation can only be accomplished by subsidies. In response to the resolution put forward at the Air Conference, the first subject upon which the Board is asked to make recommendations is the question of the cost and practicability of an Imperial air service. The first sitting of the Board was held yesterday.

Service Aviation.

IF the average man who believes that he knows something of the subject were asked to state what was being done by the Royal Air Force to develop Service aviation, he would probably underrate the effort which is now in progress to build up a military air force. A question in Parliament has, however, thrown light upon the activities of the R.A.F. There are to-day nearly 2000 machines on the establishment, of which about 800 are in active use, the remainder forming the reserve. Of those in use, from 70 to 75 per cent. are in flying trim at any given moment. The total mileage flown by Service aircraft last year was 5,000,000, of which 53 per cent. was flown in the British Isles and 47 per cent. overseas.

Position of Gas Mantle Trade.

THE Joint Industrial Council for the gas mantle industry, in view of the fact that the London County Council is inviting tenders for gas mantles, has by resolution directed attention to the fact that the factories producing 90 per cent. of the gas mantles manufactured in this country are situated in the County of London. A grave state of unemployment exists in them owing to the importation of foreign mantles at prices less than the lowest possible cost of British production. The Council urges upon the London County Council that no tender shall be accepted from any firm not carrying on a bona fide manufacture in this country.

Notable Exhibits at White City.

ALTHOUGH the bulk of the engineering exhibits in the British Industries Fair are shown at Birmingham, reference may be made to one or two groups at the London section of the Fair, which is admirably housed at the White City. One of the most important is the exhibit of fine chemicals and dyes which, until a recent period, were the monopoly of foreign manufacturers. An excellent range of chemicals for medicinal and research purposes has been produced. The advance in this field is the result of a co-operative effort by the Association of British Chemical Manufacturers. The cinematograph industry exhibit is another joint display made with the object of showing that British firms are capable of supplying the film industry with everything required for the making of pictures. A great improvement has been effected in projector design and construction, and the largest camera and projector lenses can now be obtained from home firms. On one stand is shown what is claimed to be the largest commercial lens yet produced in this or any other country.

A Commercial Trust.

ONE of the most important of recent industrial events in France is the amalgamation of four of the biggest French trading companies doing business with the Far East, Eastern Europe, South America, and the French Colonies into a Compagnie Générale Française pour le Commerce et l'Industrie. The character of the new concern is observable in the board of directors, which comprises representatives of most of the leading engineering, metallurgical and other concerns in France. The idea of the amalgamation is to create a vast organisation for developing trade with all the foreign markets, where it is possible to do business, on behalf of what amounts practically to a trust of industrial interests with the assistance of financial groups.

Wireless Telephone Developments.

IF statistics published in America this week can be accepted as an accurate representation of the position, there has been an extraordinary development of wireless telephony. It is said that the number of receiving sets in use increased in one year from 50,000 to 600,000. The usual plan is to install a small roof radial communicating with a simple receiving set, and plans are taking shape for the division of the country into definite areas for the distribution of wireless communications in the form of concerts, lectures and other public functions. The thing is becoming a craze with the American citizen, and, as might have been expected, it is being encouraged by a Press which has an uncanny knack of gauging the selling value of news features.

Railway Rates Reduction.

HOPES were raised after the recent interview between traders and representatives of railways that favourable consideration might be given to the demand for a further reduction of railway rates on merchandise. The reduction which industrial and commercial interests would like to see is to a point not more than 50 per cent. above pre-war level. The speeches of railway chairmen at shareholders' meetings during the past few days have gone far to dissipate the hopes of manufacturers and traders that a further measure of relief might be given by a lowering of transport charges. The railway argument is that until there is a further fall in wages and the price of materials the companies cannot accept the risk of the loss of revenue which they believe would be associated with any concession. Traders hold the opinion that lower rates would increase traffic and leave net revenue unaffected. Only experience could prove this, and the railways are not inclined to make experiments.

Threatened Engineering Lock-out.

NOTHING tangible has resulted from the conference between employers and the Amalgamated Engineering Union on the subject of the lock-out notices, which, unless an agreement on the points at issue is reached, will take effect next week. The particular question in dispute relates to the employers' discretion as to the working of overtime, but behind this lurks the definite challenge by the Amalgamated Engineering Union of managerial authority, and employers have raised a test case with the object of eliminating interference by men's representatives in what are regarded as purely managerial functions. The Secretary of the Engineering Employers' Federation states that at the conference on Tuesday the unions endeavoured to place upon employers the onus of finding a way out of the *impasse* which had been created. The employers pointed out that their position on the question of managerial functions had been confirmed by the Executive Council and the National and district representatives of the Union, in spite of which the recommendation had been turned down. In respect of the question whether or not the recommendation made by the accredited representatives of the Union and rejected by the members on a ballot is a question domestic to the Union, the employers pointed out that the responsibility of convincing the members that they had erred is one which rests upon the executive authority of the union and not on the employers. The executive of the Union refused to accept this position.

British Trade Ship.

THE general conditions of world trade are responsible for the decision to postpone the voyage of the British trade ship until the year 1924. A vessel of the large liner class is stated to have been purchased for conversion into the trade ship, and it is understood that this work will be put in hand at an early date. There will be agreement that the promoters of the scheme have acted wisely in postponing the sailing of the ship for twelve months. In the announcement to this effect, which was made at Newcastle a few days ago, stress was laid on the desire of the organisers of this world commercial tour that it should be undertaken in circumstances favourable to firms supporting the scheme. They had, it was stated, been influenced by the decision to postpone the British Empire Exhibition.

New Air Services.

THE arrangements which are being made by lighting the London-Paris airway, and by the use of a new type of direction-finding device, to inaugurate regular night services on the cross-Channel route, are only the forerunners of renewed activity by the air lines. The suggestion that the usefulness of the London-Paris services would be increased by an extension or linking up with provincial centres like Glasgow, Liverpool, Leeds, and Newcastle, is likely to be adopted. It has, indeed, been announced by the Newcastle Chamber of Commerce that one well-known company is prepared to start a service between Newcastle and London if 100 season ticket holders at £100 each can be secured. The Chamber of Commerce is supporting this project. Abroad, the chief item of interest is the announcement of the formation of a Russo-German air traffic company to open up the air route between Moscow and Konigsberg, to connect with the Berlin-Konigsberg express train services. The Zeppelin Company is interested in this arrangement, as well as the Hamburg-Amerika Line. This piece of news may be accepted as an indication of the forward move which will be made by Germany when, in May next, she recovers full freedom in the construction of non-military aircraft.

Railway Electrification.

THE Parliamentary Industrial Group held a meeting a few days ago under the presidency of Sir Allan Smith, at which the question of the electrification of the suburban lines of the southern railways was under discussion. Particular attention was given to the Brighton Railway problem, and the difficulties which have arisen with the South-Western and the South-Eastern companies, both of which are partners with the Brighton in the new Southern Group. The trouble arises, of course, out of the fact that the Brighton Railway has adopted the single-phase alternating-current system for its electrified lines, whereas the South-Western has adopted, and the South-Eastern Company proposes to instal, the direct-current system. As the Brighton Company intends to equip its main lines for working on the single-phase system, it would appear that interchange of traffic between that company and its partners is going to involve an awkward technical as well as a traffic problem. The Brighton Company is, however, anxious to place fresh contracts for the work of converting an additional mileage to electric traction. The intention of the Industrial Committee is to form a deputation to wait on the Parliamentary Secretary to the Ministry of Transport.

Future of German Dry Dock.

NOTHING yet appears to have been decided as to the sale to private interests of the German dry dock now lying in the Medway. The First Lord of the Admiralty, who has been interrogated on the subject in Parliament, stated that the floating dock was one of 40,000 tons built in six sections. The idea is to retain three of these sections for naval use as an alternative to constructing costly dry docks of the ordinary type, and to offer the remaining sections for sale to enlarge a 46,000-ton floating dock now lying at Hamburg and due to Great Britain under the terms of the 1920 Protocol. Negotiations which have been in progress between the Admiralty and private groups for the sale of this dock have not so far yielded any result, the tenders put in for the Hamburg dock being regarded as inadequate. This is the dock which the London and South-Western Railway, in alliance with shipping lines using that port, has entertained hopes of acquiring for Southampton.

British Industries Fair at Birmingham.

No I.

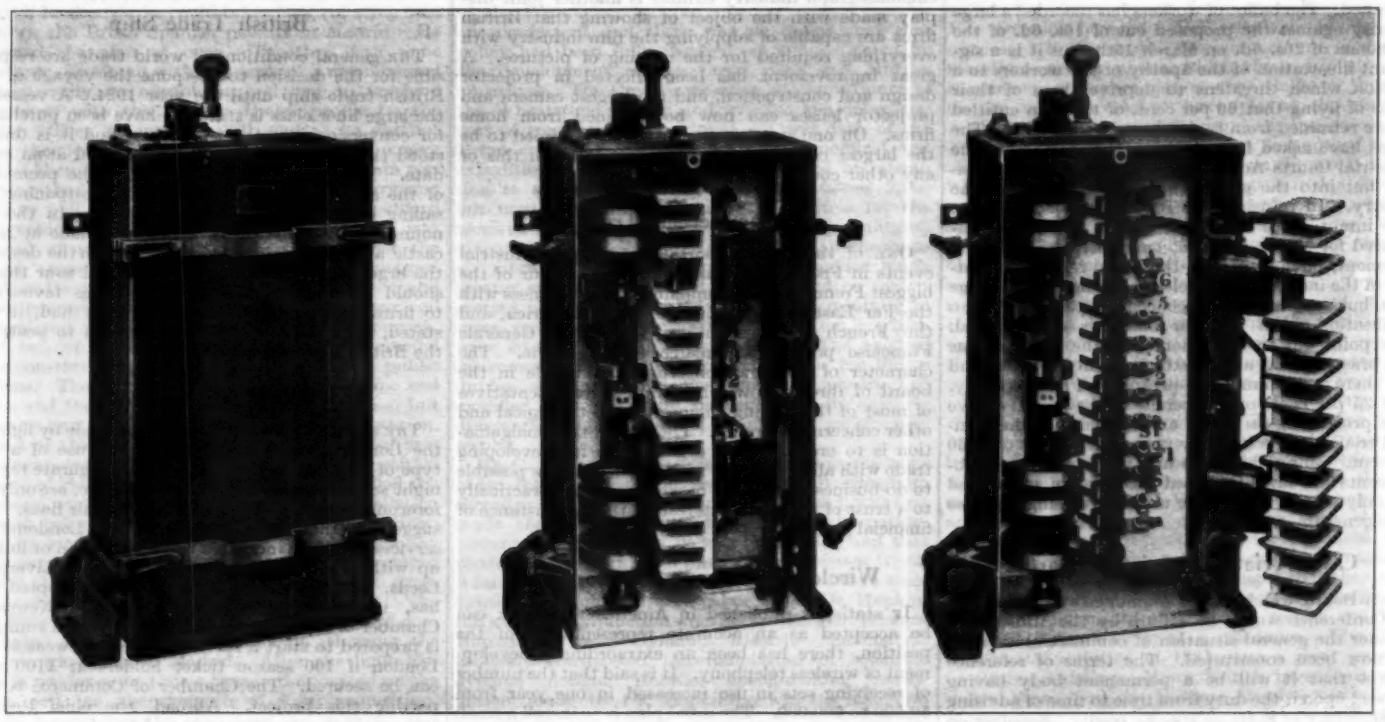
The eighth of the British Industries Fairs, which opened on February 27th, and will close on the 10th inst., is similar to its predecessors in being held simultaneously in different parts of the country. This year the heavier classes of products are being exhibited at Birmingham, while the lighter goods are being shown at Shepherd's Bush, in London. It is with the former section, which naturally includes the majority of manufactures of interest to engineers, that we intend to deal in the following notes.

The Birmingham exhibition is being held in the permanent buildings of the Castle Bromwich aerodrome, where, although it is some miles from the centre of the city, it is close alongside a railway station and a special service of trains has been run for the occasion. There are two main exhibition buildings, and the Board of Trade is to be congratulated on the efficient manner in which the whole Fair has been organised.

We commence below a description of some of the exhibits picked at random during a walk round the buildings.

Electric Controllers.

The Electro-Mechanical Brake Company, Limited, of West Bromwich, has two stands, one of which is devoted to electrical appliances, while on the other there are exhibited various types of gears and forgings.



FIGS. 1, 2, AND 3—DRUM TYPE CONTROLLER FOR ELECTRIC MOTORS—ELECTRO-MECHANICAL BRAKE CO., LIMITED

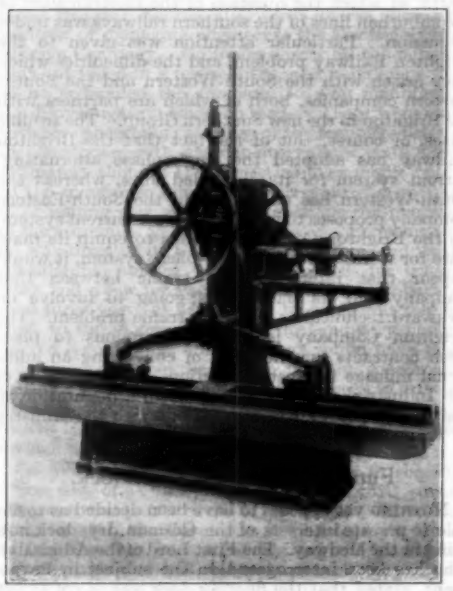


FIG. 4—AVERY'S SPRING TESTING MACHINE

connected by means of a long corridor, and the whole of the space, including the length of the corridor, is occupied by the stands. The exhibits have, to a large extent, been grouped together, so that a visitor need not wander about too much in search of any special class of manufacture, and the domestic hardware for which Birmingham is famous has been kept almost exclusively to one building, while the engineering products are quite distinct. It is noteworthy that, unlike so many other exhibitions, this one was quite ready on the opening day.

One of the most noteworthy features on the former stand is a new type of drum controller for electric motors, which has a steel plate case in the place of the usual cast iron cover. The controllers, which we illustrate in Figs. 1, 2, and 3, are made in four different types, for motors up to 100 horse-power and 500 volts, for storage battery vehicles, for small hoists and for mining purposes. The steel case is naturally light in comparison with one of cast iron, and has the added advantage that it is less likely to be damaged in transit abroad. The drum of the controller is so arranged that it is only necessary to remove four tap bolts to permit its being lifted right out of the casing, when all the contacts are, of course, fully accessible. The cases can, if necessary, be made dust or water-tight, so that they may be installed in dusty situations or exposed on the deck of a sea-going vessel.

Among the gearing on the other stand of this company there are some large spur, spiral and bevel wheels in cast iron and cast steel, up to 6ft. 6in. diameter by 10in. face, together with suitable pinions in cast iron, forged steel, special high-tensile gear steel, and other alloys. All the gears have generated teeth. There is also a good selection of clean well-finished forgings up to 10 cwt. in weight, such as shafts, cranks, discs, poppets, &c., besides a collection of weldless steel rings from a few pounds to 10 cwt. and 4ft. dia. by 18in. wide. These rings have been forged from the solid and with a minimum allowance for machining. There is also an assortment of rough and finished machined rings, which shows the trueness and accuracy which can be attained in a forged ring.

Weighing and Testing Machines.

W. and T. Avery, Limited, of Soho Foundry, Birmingham, have, as might be expected, a large collection of weighing machines, but there are also on this stand several other machines of more direct interest to engineers. Among these there is the spring testing machine, illustrated by Fig. 4, to which we referred in describing recently the new overhauling depôt of the London General Omnibus Company. The laminated spring to be tested is placed upon trolleys upon the weighing platform, and the screw ram is brought down to bear upon it by means of an electric motor which can be seen at the back of the standard. The pressure upon the spring is recorded by the sliding poises upon the weighing steelyard, and the deflection is indicated by a pointer attached to the screw operating against a deflection scale. Coil springs are placed in the middle of the platform and are tested in the same manner.

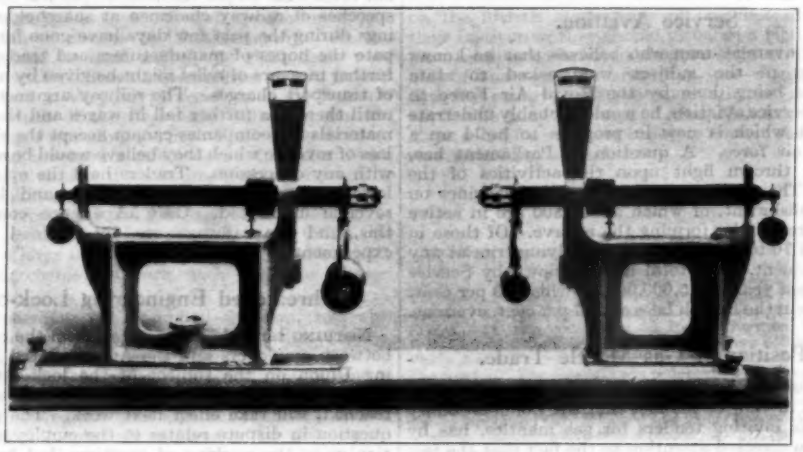


FIG. 5—AVERY'S BALANCING MACHINE FOR CONNECTING RODS

There are several other testing machines, including the hardness testing machine, which we have already described, a 50-ton universal testing machine, impact, cement and rubber testing machines, and the balancing machine for connecting-rods shown in Fig. 5. This machine is for the purpose of accurately balancing the connecting-rods of internal combustion engines to one common standard, thereby ensuring smooth running of the engine. A standard connecting-rod is placed in position in the machine and is there balanced off by moving the poises upon the steelyards until the automatic indicator shows zero. The rods to be tested are then placed in succession in the machine, and any deviation in end weight from the

standard rod is instantly shown, plus or minus, by the pointers of the automatic indicators. The rods are then corrected by removing some of their substance as required.

GUNS, SMALL TOOLS, CYCLES, &c.

The exhibits of the Birmingham Small Arms Company, Limited, are naturally very varied in their character and range from powerful motor cycles, fitted with side cars, to sporting guns and small tools. With one exception the guns need not be referred to at greater length here, but the one exception appears to us to have such a wide scope of possible services and is so novel as to warrant a brief description. This gun, of which a line drawing is given in Fig. 6, is intended for throwing a line in much the same way as the rocket life-saving apparatus used round our coasts, but with much greater accuracy and more expeditiously. Over the barrel of the gun, it will be seen, there is slipped a tin canister which contains the coil of rope or line. The end of the line is brought out at the front and is clipped on to a long projectile which is thrust down the bore of the gun. A cartridge is inserted in the breech and when it is fired drives forward the projectile, carrying with it the line. The gun is said to be capable of throwing a line $^{1}/_{16}$in. in diameter to a distance of 110 yards. Such a line has a breaking strain of 125 lb. For heavier service a $^{3}/_{16}$in. line, with a breaking strain of 400 lb., is used, and it can be thrown to a distance of some 70 yards. The gun referred to is intended for firing from the shoulder and weighs 14¾ lb., including the canister and projectile; but there is a heavier type shown in the illustrations. Fig. 7 represents an electric lighting set driven by a vertical engine giving from 5 to 6 horse-power when running at from 500 to 600 revolutions per minute. One of the outstanding features of the engine, it will be noticed, is its accessibility, and in this respect it closely resembles a high-speed steam engine. The cam shaft is driven by a vertical shaft through machined-cut spiral gear wheels which continually run in a bath of oil. The cams and rollers are of hardened steel and they also run in oil. The exhaust and inlet valves are of the overhead type and are made of high-grade nickel steel. They are fitted in loose cast iron cages, which carry the operating lever; consequently the cages, complete with valve, can readily be stripped without interfering with any other portion. The governor is fixed on the top of the vertical shaft and operates a throttle valve, which obtains its supply from a glass sight-feed lubricator fitted on the column. The gear wheels, cams and rollers run in an oil bath, thus ensuring a minimum of wear, and a quiet-running engine.

The self-contained plant shown in Fig. 8 develops 2 brake horse-power and uses charcoal as fuel. It was originally designed for the South African market, where the prices of paraffin and refined oil are prohibitive, and the farmer is able to make his own charcoal, so that the running costs are exceedingly low. The gas plant generator is simply a cast iron shell without brick lining. All the steam required for the generator is raised from the grate, so that there are no complicated pipes in the system. The scrubber is a small cast iron shell which can be filled with coke, broken brick, &c. There is a small tank fitted on the top of the scrubber, from which the latter receives its supply of water, and the same tank supplies water to the grate. With charcoal there is generally a small amount of tar produced, and the engine is fitted with a small tar catcher. The engine is fitted with a centrifugal ball governor, to ensure steady running with economical gas consumption in proportion to the duty. The ignition is effected on the low-tension system and the gear is so designed that the sparking plug can easily be withdrawn. The engine is fitted with a loose cylinder liner of special hard cast iron, which can be renewed or re-bored at any time at small cost. Separate gas, air, and exhaust valves are fitted, all with loose covers, making them easily accessible for cleaning purposes. A forged steel crank shaft, machined bright all over and of exceptional strength, is fitted to the engine.

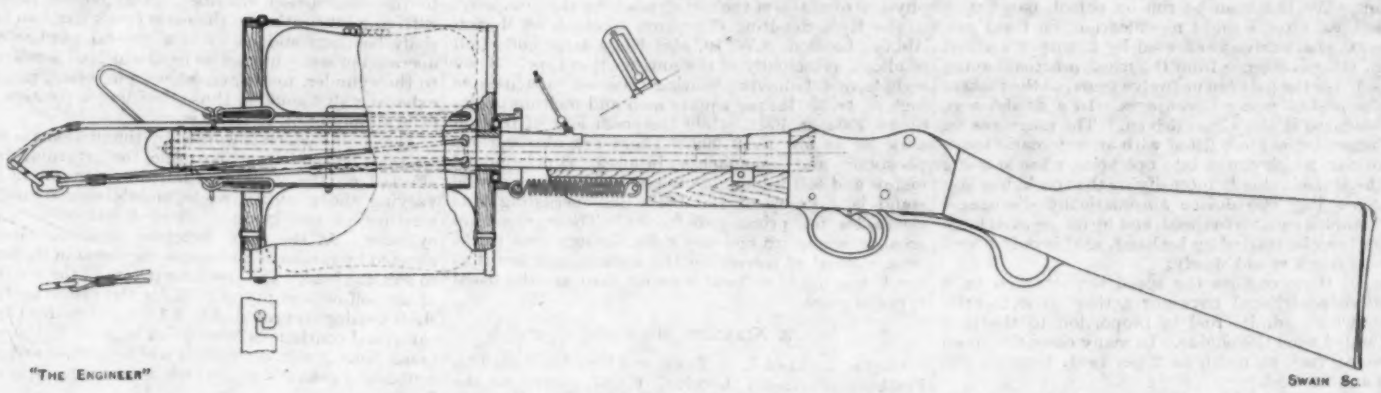


FIG. 6—B.S.A. GUN FOR THROWING LIFE LINES

SMALL GAS ENGINES.

Owing to the limited space available, the National Gas Engine Company, Limited, of Ashton-under-Lyne, has been able to exhibit only some comparatively small engines, and those shown, two of which we illustrate in Figs. 7. and 8, do not go beyond 50 horse-power; but this company does, of course, manufacture gas engines of up to 2000 brake horse-power, those of 300 horse-power and upwards being of the vertical tandem type. There are on this stand several gas engines, a gas-making plant for burning anthracite, coke or charcoal, and a small oil engine, and among them two of the most interesting are those

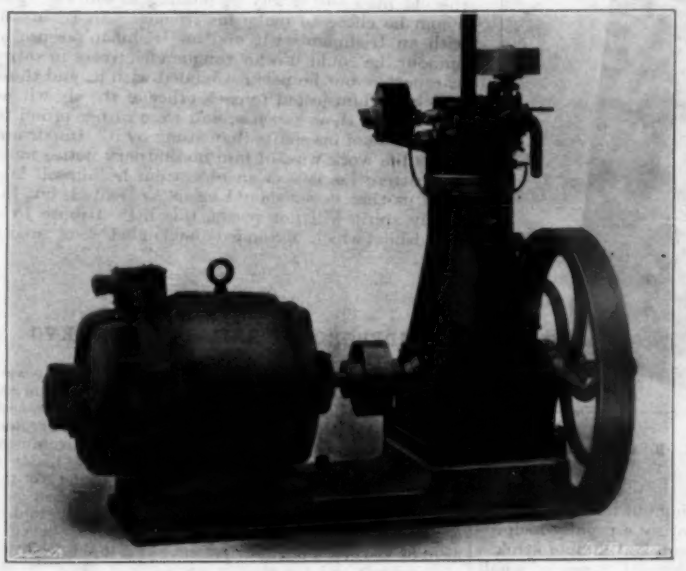


FIG. 7—5-6-H.P. NATIONAL "L.V."-TYPE ENGINE AND DYNAMO

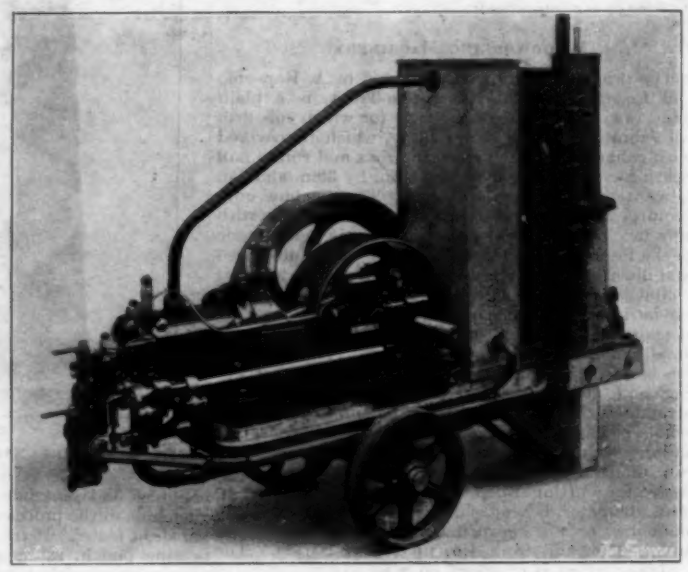


FIG. 8—NATIONAL ENGINE AND CHARCOAL SUCTION GAS PLANT

for mounting on a pedestal, which has a considerably greater range.

Among the motor cycles exhibited by this company the most noteworthy are the new 6 horse-power and 8 horse-power twin-cylinder machines. These two are developments of last year's 6/7 horse-power machine, and have already shown their worth in numerous trials during the past season. The 8 horse-power is a machine designed for side-car work in any country and has interchangeable wheels, cast aluminium chain cases and generous mudguarding. The 6 horse-power model, known as the "Light Six," is a smaller edition of the 8 horse-power and is intended either for solo or side-car work.

The small tools on the stand include high-speed steel twist drills, reamers, milling cutters, form cutters, taps and dies, spanners, sleeves and sockets, chucks, &c., while a selection of jigs and fixtures gives some idea of the capacity of the company's works in that direction.

OIL ENGINES.

Petters Limited, of Yeovil, are exhibiting a number of their oil engines, most of which are well known to the readers of THE ENGINEER, and thus do not need detailed description here. The engines on the stand are mostly of the smaller type, of from 2½ up to 10 horse-power, and arranged for general service, electric lighting and marine work. One of the most novel of the engines is a 1½ horse-power set, adapted for working on petrol or paraffin, which we described in connection with the recent Smithfield Club Show. The engine cylinder is provided with a water hopper for cooling, so constructed that when it is required to work for long periods a water tank can easily be added. The engine has magneto ignition and is furnished with two heavy fly-wheels.

One of the 2½ horse-power engines is fitted up in conjunction with a force pump, which will deliver 350 gallons per hour against a head of 150ft. The pump is driven through a belt, running on fast and loose pulleys, and a set of machine-cut gearing. The pump has a brass-lined barrel and a gun-metal piston-rod. The engine and pump are mounted on a substantial wood frame, and as the cylinder is arranged with a hopper-cooled head it is unnecessary, unless the engine

has to be run for long periods of time, to make any other connections than those necessary for the pump. The marine engine has two cylinders and develops about 6 horse-power. It can be worked at any speed between 250 and 700 revolutions per minute and is capable of driving a propeller from 15in. to 17in. in diameter. There is also a 10 horse-power engine, with a single cylinder, suitable for working on crude or residual oils. It has a cylinder 7¼in. in diameter by 8in. stroke and runs at 425 revolutions per minute. The fuel consumption of these engines is said to be from 0.5 to 0.6 pint per brake horse-power per hour.

On Stand No. 176 the Heatly-Gresham Engineering Company, Limited, of Letchworth, Herts, is showing a number of small power oil engines of the vertical, four-stroke cycle type. The engines are totally enclosed and provided with automatic lubrication, while they can be run on petrol, paraffin or alcohol, or, after a slight modification, on town gas. The cam shaft drive is effected by means of a silent chain, this divergence from the usual practice having proved over the past ten or twelve years, so the makers say, to possess many advantages. In a similar way the magneto is also chain driven. The magnetos on the larger engines are fitted with an automatic spark intensifier, which comes into operation when starting up, the action not only intensifying the spark, but also retarding it. The device automatically disengages as the engine runs up to speed, and by its use even large engines can be started up by hand, as it is only necessary to crank round slowly.

In all these engines the speed is controlled by a sensitive centrifugal governor acting on a throttle valve which admits fuel in proportion to the load demanded from the engine. In many cases the speed does not vary as much as 2 per cent. between full load and no load.

The Heatly-Gresham Company produces in its own works practically every component part of its engines. The forgings are made in dies, while the castings are made on modern machines, and the machining of all the parts is effected with the aid of jigs and within defined limits.

Among the combined sets shown are some very compact and handy electric generating sets suitable for country house and farm light and power requirements. The dynamos of these sets have been lent by Electromotors, Limited, Openshaw, Manchester. A standard battery charging switchboard by Crompton and Co., Limited, Chelmsford, is also exhibited, together with a model storage battery manufactured by the Pritchett and Gold and Electric Power Storage Company, Limited, 50, Grosvenor-gardens, London, S.W. 1. One of the oil engines is direct coupled to a centrifugal pump lent by the Chalmers-Edina Company, 39, Assembly-street, Leith, the whole arrangement being very handy and occupying a minimum of floor space. The engine is cooled from the pump itself. Another set is an oil engine driving a vacuum exhauster or air compressor.

Woodworking Machinery.

The principal exhibit on the stand of A. Ransome and Co., Limited, of Newark-on-Trent, is a plain band sawing machine of the type for which this firm is celebrated. It has 30in. pulleys, which are covered with rubber vulcanised on to the rims and run in ball bearings. The table measures 36in. by 39in. and can be canted to an angle of 45 deg. The machine only requires 2 horse-power to drive it. In connection with this machine a special demonstration is being made of the Ransome and Newell band saw guide, described and illustrated in our issue of February 24th, which is claimed greatly to increase the life of band saws by obviating the likelihood of their being kinked. Another machine on this stand is an automatic sharpener for small circular and narrow band saws. This machine has been specially designed for automatically sharpening and gulleting the smaller sized saws having straight cut teeth of any pitch from ¼in. to 1¼in. The whole profile of each tooth is rapidly and accurately ground at one operation by means of a grinding wheel 8in. diameter. The machine will deal with circular saws, for cutting wood or metal, from 6in. up to 24in. diameter, having centre holes from 1in. to 1¼in. diameter, or will sharpen band saws of any length up to 25ft. and from ¼in. up to 2½in. wide. The grinding wheel is mounted on a spindle running between centres fixed in a hinged carriage. A quadrant is provided for canting this carriage to suit the hook of tooth required. In addition to the quadrant another adjustment is provided so that the grinding wheel can be canted to give a clearance to the wheel when grinding the face of the teeth. The speed of the grinding wheel should be 2250 revolutions per minute. The saw is fed forward by means of a hardened steel pawl engaging in the tooth which is actually to be ground. Two separately adjustable excentrics control the movements of the feed pawl and grinding wheel carriage. Teeth with flat bottom gullets can be sharpened by means of other adjustments which are provided. There are two rates of feed, namely, sixty teeth per minute for short pitches and thirty teeth per minute for longer pitches.

Non-ferrous Metals and Alloys.

It is only natural, in view of the fact that the extrusion process was the invention of the late Mr. Alexander Dick, who was chairman of the Delta Metal Company, that the products of that process should form a prominent part of that company's exhibits, and extruded bars are shown ranging from pinion wire weighing a few ounces per foot up to heavy sections of 40 lb. or more per foot run. These bars are produced in brass, yellow metal, white metal, naval brass, bronzes, copper, &c., either in special complicated shapes and forms or as plain round, hexagon, square, flat, and other rods and bars, in lengths as required. Among the Delta bronzes exhibited there are the No. I. alloy, which is said to have a tensile strength of about 50 tons per square inch, and the No. II., an improved german silver. Some heavy forgings in No. IV. alloy are shown, and we were informed that the company can make such forgings up to 3 tons weight. There are also a number of test pieces and specimens which illustrate the physical qualities of the metals made by this company.

The Eyre Smelting Company, Limited, of Merton Abbey, London, S.W. 19, also has a large collection of alloys, principally of the anti-friction type. They include metals having bearing pressure capacities as high as 18,000 lb. per square inch and melting points up to 500 deg. Fah., while the coefficient of friction may be as low as 0.002. There are also various phosphor and manganese bronzes, typefounders' metals and soft solders. A noteworthy feature on the stand is a group of Bamber's non-encrusting zinc electrodes for primary batteries. These zincs are amalgamated with mercury right through their thickness, instead of merely on the surface, and are thus much less liable to local wasting than are the usual types of zincs.

A Nibbling Machine.

On the stand of J. B. Stone and Co., Limited, 135, Finsbury-pavement, London, E.C. 2, there is the machine illustrated in Fig. 6. It is known as Wilson's

FIG. 9—NIBBLING MACHINE—J. B. STONE AND CO.

Nibbler, and is intended to take the place of the drilling machine in the process of cutting out irregular shapes in sheet metal. It really comprises a rapidly reciprocating punch, running at about 300 double strokes per minute, with a specially formed punch of small size. The material to be cut is fed up to the punch, which literally nibbles its way along and can naturally follow round curves of quite small radius. The machine will cut through any metal up to $^{3}/_{16}$in. thick and at a speed of 20in. per minute. It requires less than ½ horse-power for driving. The edge of the work is quite clean and sharp as it leaves the machine and for many purposes does not even need filing to finish it.

Oil and Suction Gas Engines.

Tangyes Limited, of Cornwall Works, Birmingham, are exhibiting a variety of machines, and among them there stand out prominently an oil engine and a suction gas plant. The oil engine is the outcome of exhaustive tests carried out under both experimental and working conditions, with practically every class of oil fuel which is available, or even alcohol, and it has been developed to such an extent that it will run satisfactorily on any of these fuels. It is of the solid injection type and thus has no external vaporiser, while the engine can be started by compressed air from cold without the use of a heating lamp or electric ignition. The combustion chamber is fitted with a hollow cover or sheath, which carries a spray maker that permits low-grade heavy fuel oils, containing a high percentage of asphaltum or bitumen, to be satisfactorily used, without having recourse to cleaning the combustion chamber or valves. The spray maker superheats the fuel oil before it passes through the non-drip fuel nozzle into the combustion chamber. The governing of the engine is effected by varying the quantity of fuel oil injected through the spray maker in proportion to the load, the fuel oil being delivered by means of a pump operated by a cam on the side shaft through a variable operating gear. This gear is controlled by a sensitive governor of the spring-loaded revolving type, and varies the stroke of the fuel oil pump and therefore the amount of oil delivered to the combustion chamber. This engine is fitted with ring lubrication to the main crank shaft and side shaft bearings and also has a central mechanically operated pressure lubricator from which oil is delivered to the cylinder, piston, crosshead pin, crank pin, and exhaust valve spindle, thus providing a positive and even supply of oil to those parts.

The engine which is worked by the suction gas plant operates on the four-stroke cycle, the governing being effected on the variable admission system, *i.e.*, by varying the quantity while maintaining a uniform mixture of the gaseous charges admitted to the cylinder. At the same time the ignition, which is effected by means of a magneto, is varied in its timing to suit the load. The sparking points of the plugs are of the self-cleaning type. Oil for the piston and side shaft bearings is provided by a forced sight-feed lubricator, and continuous lubrication is given to the main crank pin. A splash guard, it will be seen, is arranged round the crank shaft, which is cut out of a solid forging.

This company is also exhibiting a hydraulic press suitable for a working load of 300 tons, having a ram 14in. diameter by 18in. stroke, for a working pressure of 2 tons per square inch, together with a two-throw hydraulic pressure pump. There are various examples of steam and power pumps for boiler feeding and general pumping purposes, and a Tangye "Quick-speed" vertical steam engine, suitable for dynamo driving or other purposes where accuracy of running is an essential feature. A large variety of lifting blocks, hydraulic and screw lifting jacks, hydraulic punching bears, &c., completes the exhibit.

DRUITT HALPIN.

There are many indeed who will learn with sorrow that the long illness from which he had suffered ended in the death, on Monday last, of Druitt Halpin, for the old man had a way of binding to himself those whom he chose to make his friends. An Irishman, with an Irishman's wit and an Irishman's sense of humour, he could use his tongue effectively in satire or repartee, but he never wounded with it, and those who knew him jested to each other of the sly wit he had used at their expense, and were rather proud to receive one of his shafts than stung by it. Important as his life work was, of him no obituary notice must be written, for it was an obligation he himself laid upon us that never should he be so treated, but his kindly spirit will not resent this little tribute to a friendship which extended unclouded over many years.

UNDERGROUND RAILWAY FOR TOKYO.

The prospects of the Tokyo Underground Railway were dealt with at some length in an article published in the December number of the *Japan Financial and Economic Monthly*. It is stated that the Tokyo Underground Railway Company was promoted and received Government sanction in 1919, with a capital originally fixed at 40,000,000 yen, which was afterwards, owing to the financial depression of the spring of 1920, organised on a basis of 10,000,000 yen. In Tokyo the traffic problem is acute and it cannot, apparently, be solved by development of the motor omnibus system owing to the condition of the roads and the electric wires which run overhead lengthwise and crosswise. An underground railway is therefore generally desired, but misgivings were felt on the grounds of lack of experience in that class of work, and also on account of the general supposition that the subsoil of Tokyo is of too soft a nature to make the project a paying proposition. The experimental borings of the company, however, have disproved that supposition, and the feeling now is that the scheme will be successfully accomplished. The article gives estimates of costs and revenue for a line between Shinagawa and Kaminarimon, Asakusa Ward, *via* Uyeno—a distance of 9½ miles—and a line between Kurumazaka, Shitaya Ward and Ohashi, Senju, in the suburb—a distance of 1½ miles—and arrives at the conclusion, based on what are said to be conservative figures, that a profit of 13 per cent. would be realised on a paid-up capital of 40,000,000 yen. Of that sum, only 1,000,000 yen has up to the present been paid up, but it is anticipated that when the prospects of the railway become known it will be possible to raise the required capital outside Japan, in countries in which capitalists have a fair knowledge of underground railway works—even if the task presents difficulty in the domestic market.

Railway Matters.

THE Government of Kenya Colony intends to float a further loan of £3,000,000 for the purpose of completing the construction of the Uasi-Ngishu Railway.

It is remarked in the annual report of the North Staffordshire Railway Company that no scheme for amalgamating the constituent companies in the North-Western, Midland, and West Scottish group has, as yet, been considered.

FOUR powerful steam locomotives were placed in service on the Metropolitan Railway last year, and forty-seven new electric cars have been delivered. Three electric locomotives were re-equipped with higher-powered motors and are now working, and all the other electric locomotives owned by the company are gradually being dealt with in a similar manner.

WHITE Paper Cmd. 1494, noted on page 236 of our issue of September 2nd last, has been cancelled and superseded by 1494†. It related to the number of persons employed on the railways, and compared it with 1913. As the present figures, 766,381, include men in many grades in the subsidiary railway services which were omitted in 1913, an unwarranted increase was shown—one of about 25 per cent.—and so a new paper has been issued without the 1913 figures.

ON the subject of automatic twin control ordered by the Inter-State Commerce Commission, as to which a leading article appeared in our issue of February 3rd, it is of interest to note that the *Railway Age* (New York) asked, in its issue of January 21st, how this costly improvement is to be paid for. Under the Transportation Act, 1920, the Commission can, in theory, improve the railways' incomes to match their increased expenditure but no one knows, as yet, how this theory is going to work out.

THE Argentine Government has recently signed an agreement with the Bolivian Government for the construction of a railway in Bolivia on the understanding that Bolivia can purchase at any time she desires. The line is to connect across the border at Yacuiba with the Argentine system, and tap territory in eastern Bolivia, from which it is expected Argentina will be able to draw valuable raw materials. The development of petroleum fields in eastern Bolivia is expected to be one important result of the undertaking.

DURING November last, when compared with November, 1920, the tonnage of general merchandise decreased 14.7 per cent. and the ton-miles 13.1 per cent.; the tonnage of coal, coke and patent fuel increased 8.4 per cent., and the ton-miles 7.5 per cent.; the tonnage of other minerals decreased 31.3 per cent., and the ton-miles 30 per cent. The tonnage of all freight traffic decreased 4.9 per cent., and the ton-miles 6.3 per cent., but the figures were the best for any month of the year—the result of the increase in coal traffic. The freight train mileage fell by 3.2 per cent. The average wagon and train loads were 5.46 tons and 126 tons respectively, compared with 5.39 tons and 130.13 tons in November, 1920. The improvement in the rate of movement was maintained, and the net ton-miles per engine hour were 428 as against 405 in the corresponding period of 1920.

THE annual report of the South-Eastern and Chatham Joint Managing Committee states that the Committee has for some time past been considering the means of providing adequate accommodation for the traffic on its railways and has arrived at the conclusion that the only method of doing so is by the introduction of electric traction. Up to the present time there has been no opportunity of raising the necessary capital for the work, but the Committee has now considered it expedient to avail itself of the powers conferred by the Trade Facilities Act, 1921, and has approached the Advisory Committee appointed under that Act with the object of obtaining capital under the guarantee of the Government. The details are still under discussion, and in the event of terms being arranged, it will be necessary for the Order to be submitted to the shareholders of the two companies for their approval at special meetings to be called for that purpose.

THE Barry Railway is destined to be part of the Western group, but objects to being so dealt with. The annual report says: "Your undertaking was authorised by Parliament as a competitive undertaking. Ships were lying idle in the channel for weeks waiting for admission into the then existing docks and the railways were blocked with traffic. The opening of your undertaking for traffic not only relieved the shipowners and colliery proprietors from the enormous losses sustained by reason of the extraordinary delays at the docks and on the railways, but the railway rates on coal for shipment were most substantially reduced. The relief from loss, the reduced railway rates and facilities given by reason of the construction of your undertaking greatly expedited the development of the South Wales coalfield. The town of Barry, with its inhabitants, has been created and employment has thereby been given to many thousands. The directors regret that without any inquiry or detailed evidence this beneficial competition is to be put to an end."

THE average coal consumption per train mile on the Midland Railway was 72.40 lb. in 1913 and 81.76 lb. in 1921. The explanation given by the Midland chairman for this increase is that in 1913 they were getting their normal supplies from Yorkshire, Derbyshire, and Nottinghamshire collieries. The enginemen, always getting the same class of coal, knew its qualities, knew what they could get out of it, and regulated their firing accordingly. In 1921 they were for a considerable portion of the year burning just what they could get. A considerable amount was obtained from abroad, some of which was really rubbish, but they had to take it and make the best of it, or close down, at all events a portion of the railway. The enginemen complained very strongly. They could not keep up the necessary pressure of steam to enable them to run to time even by burning abnormal quantities, and the whole business was in every way very unsatisfactory. For these reasons, the figures quoted were of no value for purposes of comparison, but now that they were getting back to the 1913 position as to quality, proper supervision could usefully be exercised in respect of the quantity consumed, and much better results would obtain.

Notes and Memoranda.

THE American General Electric Company announces the development of a complete plant for producing 2 kilowatts of direct current at 200,000 volts. The equipment used consists of the following apparatus:—A 10 horse-power motor coupled to a 2000-cycle alternator; a main transformer; four 10,000-volt kenotrons; four filament transformers; two 100,000-volt condensers; and a switchboard.

A SIMPLE process for boring holes in furnace "skulls," preparatory to breaking them up with explosives is described in a recent issue of *Industrial Gases*. A small coal fire is made on the skull and a jet of oxygen is directed against it through a length of ¼in. gas barrel. Two holes 14in. deep by 1¼in. diameter can be made with 100 cubic feet of oxygen, whilst about 14ft. of the gas pipe will be burnt away in the process.

WITH the object of accelerating the introduction of the international metric system, the Decimal Association now recommends gradual modification of the existing imperial system of weights and measures. For instance, it is proposed that the existing table of avoirdupois weights would be greatly simplified and that closer co-ordination with the metric system could be secured by the present adoption of the following interim table:—7000 new grains, 1 metric pound; 16 new drams, 1 new ounce; 16 new ounces, 1 metric pound; 2000 metric pounds, 1 metric ton. The metric pound and its parts would weigh about 10 per cent. more than the imperial pound, and 2 such metric pounds would be exactly 1 kilo.

FOR the purpose of standardising, as far as possible, specifications for and the sizes of commercial dry cells, the American Bureau of Standards recently called a conference at which the majority of the manufacturers of such batteries, together with a large number of users, were represented. The work was not new to the Bureau, as considerable progress had been made during the war in co-operation with the War Industries Board. At this conference seventeen sizes of the larger dry cells were considered, and seven were recommended as standard. Thirty different sizes and kinds of flashlight batteries were considered, and eight adopted as standard sizes. Two sizes of batteries were also recommended as standards for use with wireless outfits. It is expected that the elimination of many sizes for which there is but little demand will result in a considerable saving in the cost of manufacture. When it is considered that on an average 150,000,000 dry cells are, it is said, sold in the United States each year, this is a matter of considerable consequence. Specifications were also adopted for the performance of dry cells.

EXTENSIVE drillings into the great active volcano of Kilauea, on the island of Hawaii, are to be undertaken this year in an endeavour to determine the heat of the volcano, the quantity of steam underneath, the mineral constituents, and the solution of other related questions. Borings are to be undertaken at the sulphur banks, at several places in the bottom of Kilauea crater, and in the region of recent lava flows at Kau desert. It is intended to penetrate the surface where the lava flows are of known date so as to learn what changes of temperature underground have taken place with the passage of time. The most important scientific and practical problem involved in the borings is how hot is the volcano and what are the steam and water conditions under an active volcano. According to Professor Jagger, the practical side of the knowledge of underground temperature which the borings will give depends on what is learned as to chemical activity which maintains the high temperature in such a boring after the ground is opened to air. If high temperatures are maintained so, possibly at red heat, for years, it would, he considers, be possible to utilise the heat for power.

A CONDEMNATION of present day methods of lighting was made by Mr. C. G. A McDonald in a recent lecture on "Illumination" to the members of the Birmingham and District Electric Club. In our homes we had, he said a lay-out which followed in almost every detail the original lay-out in vogue when gas first became a commercial proposition. The only development worthy of note was the incandescent burner and mantle. At home, to sit in front of a fire and at the same time fix a paper or book in a suitable position for reading was an impossible task unless one was a contortionist. In the office, in the workshop, in almost every phase of life, we had horrible examples of how not to carry out lighting schemes. Our street lighting had not been improved upon since street lighting first became the policy of municipalities. The lighting of our shop windows, with few notable exceptions, was appalling. It was a grave reflection upon electrical engineers that such a condition of things should exist and the logical conclusion was that those of them who were responsible had either been woefully ignorant or wilfully neglectful of the first principles of artificial lighting.

A PAPER on "Electric Arc Welding in Steel Structures" was recently read by Major James Caldwell before the newly-formed South Wales Branch of the Institution of Mechanical Engineers. The author said that in both technique and practice advances had been made. The adoption by experiment of the best forms of electrodes and fluxes for various kinds of steel, the correct voltage, current, and size of electrode for welds in materials of various dimensions were among the matters which were now calculable to a great degree of accuracy. There was still, however, plenty of room for further improvements. Tests had shown that welds in mild steel structures had a tensile strength equal to the steel itself; in fact, as a rule, the weld was slightly stronger, as was proved in tensile tests where the break occurred outside the weld. As regarded ductility, the characteristics of welds were not so good. Under alternating and impact tests welds showed up favourably, and in mild steel welds the modulus of elasticity was practically the same as that of the steel. Arc welding compared favourably with riveting with respect to the time taken to do the work. The absence of a supply of electricity on the site was not a big handicap, as portable welding sets were easily obtainable. Arc welding also reduced the weight of the finished work, as it was generally possible to dispense with the gussets and other stiffening pieces required in riveted work.

Miscellanea.

WITH the object of demonstrating the advantages of portable electric tools, an exhibition of labour-saving appliances was recently organised by the General Electric Company, Limited, in its showrooms at Magnet House, Kingsway, London.

THE Aberdare Mining Engineering Laboratory, which was recently officially opened, has been designed to meet the requirements of mining engineering students in the county, and is one of six of the kind which the County Council has in contemplation.

AN Order has been issued by the Board of Trade laying down that no gas undertakers, as defined by the Gas Regulation Act, 1920, shall supply any gas for domestic purposes containing carbon monoxide unless such gas possesses the distinctive pungent smell of coal gas.

WE hear that it is proposed to construct a light railway from Ching Lung Kiang, Haimen, to Sze Yang-peh, Nantungchow, to be called the Ching-Yang Railway. The necessary capital has been raised, and an engineer has been appointed to start the construction.

THE new South American branch of the Institution of Locomotive Engineers has elected Mr. M. F. Ryan, chief mechanical engineer, Central Argentine Railway, as chairman, and Mr. A. W. Bannantine, chief mechanical engineer, Buenos Aires Western Railway, as vice-chairman.

THE preliminary investigations in connection with the creation of an aerial service between Seville and Buenos Aires have been completed, and steps are being taken to raise the funds necessary to enable actual work to be commenced. The amount required is 100,000,000 pesetas.

WE hear that a Committee has been appointed to discuss the co-ordination of the work of the various Admiralty chemical laboratories. It will consider the scope of all work now carried out at the various laboratories in the Admiralty service, and will report whether any changes can be made with due regard to the requirements of each department interested in the work to avoid dissipation of energy, overlapping of duties, and unnecessarily different conditions of service.

JUDGMENT has now been given by the referee under Section I. (5) of the Safeguarding of Industries Act in the matter of the complaint by the British Cellulose and Chemical Manufacturing Company, Limited, that calcium carbide had been improperly excluded by the Board of Trade from the lists published by them of articles chargeable with duty under Part I. of the Act. The award, which is dated February 25th, is that calcium carbide is properly excluded from the list published by the Board of Trade.

A LIGHTHOUSE has been inaugurated at Cuatro Vientos aerodrome at Madrid. The light is on a cylindrical tower resting on a stone building, its height above the ground being 75ft. The light itself is produced by acetylene gas, and is between 4000 to 5000 candle-power. It spells out the letters H T I, that is, four dots of half a second each, eclipse two seconds, one dash of three seconds, eclipse two seconds, two dots of half a second, eclipse two seconds. The lighthouse will only be illuminated when notice has been given of the impending arrival of aeroplanes.

THE preliminary report on the mineral production of Canada in 1920 was published on February 24th, 1921, the statistical record being at that time partially estimated, and, therefore, subject to revision. According to the revised statement now presented, the total value in 1920 was 227,859,665 dols., over ten million dollars in excess of the total value estimated in the preliminary report. Compared with the total value of the production in 1919, which was 176,686 390 dols., that of 1920 shows an increase of about 29 per cent., and the highest production on record.

AT a meeting of the Finance Committee of the French Chamber a deputy suggested that British and American firms should be given contracts in the work of restoration of the devastated districts of France, in order to alleviate the unemployment crisis in Great Britain and the commercial crisis in the United States. He asked the Government in this connection if it would not be possible to induce some of these firms to accept in payment for the reconstruction work bonds of one or other of the A, B, or C categories provided for by the schedule of payments agreed upon in London last year, and annexed to the Treaty of Peace.

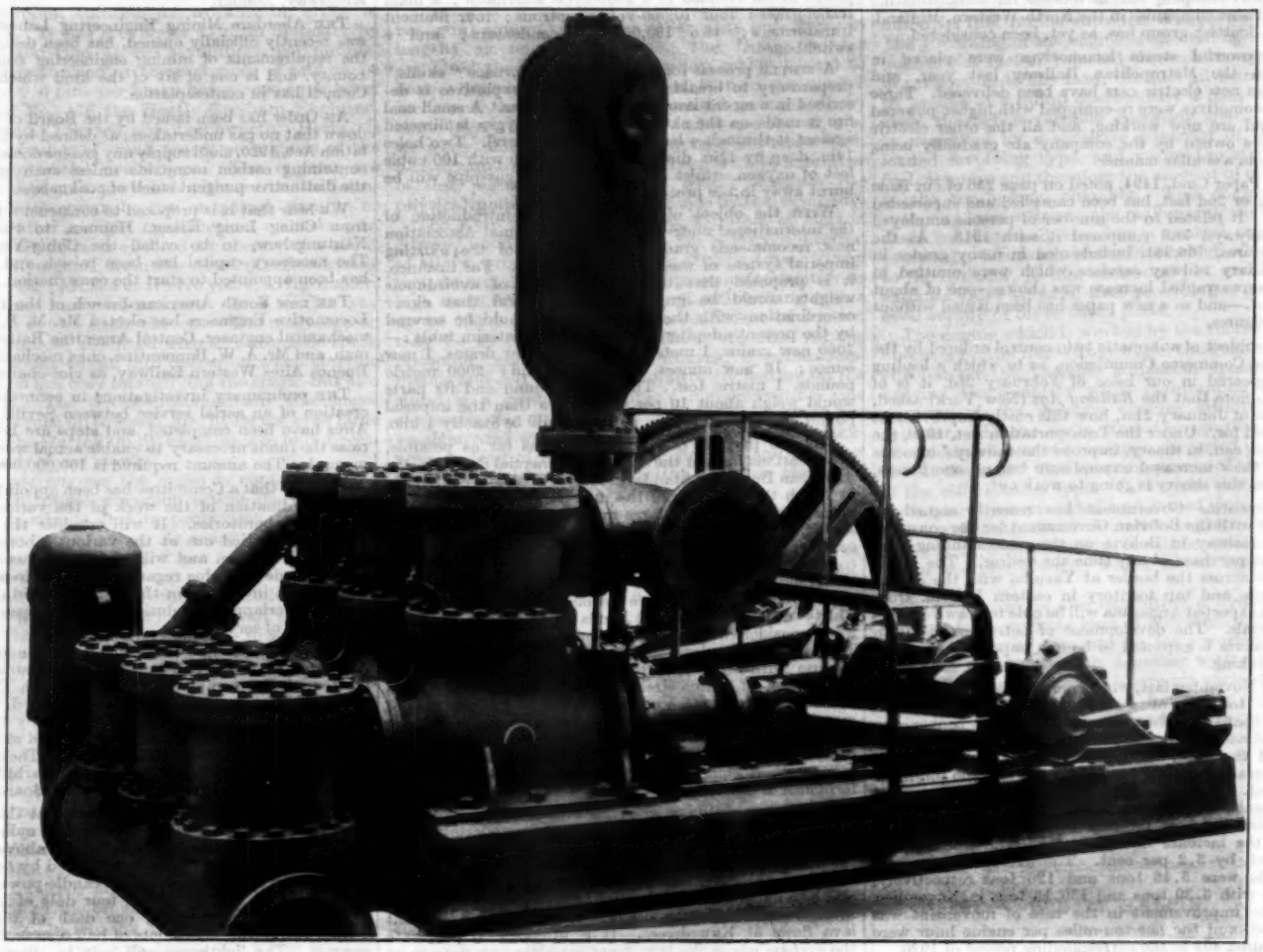
A COMMITTEE composed of headmasters of public secondary schools has offices at Howard Hotel, Norfolk-street, Strand, W.C. 2 (Telephone Central 5429), and interests itself in the problems confronting the boy of sixteen and upwards who has left school and is taking his first step in professional or commercial life. This Committee, which renders voluntary service, has placed 251 boys in employment during the last six months, the majority in banks and insurance offices. There remain, however, many boys of marked technical ability for whom openings in their chosen professions are few and far between. The Committee believes that employers will find it of real benefit for boys to be introduced to them from public secondary schools, who have received a sound general education of approved standard up to the age of sixteen or eighteen years, and who are personally recommended by their headmasters.

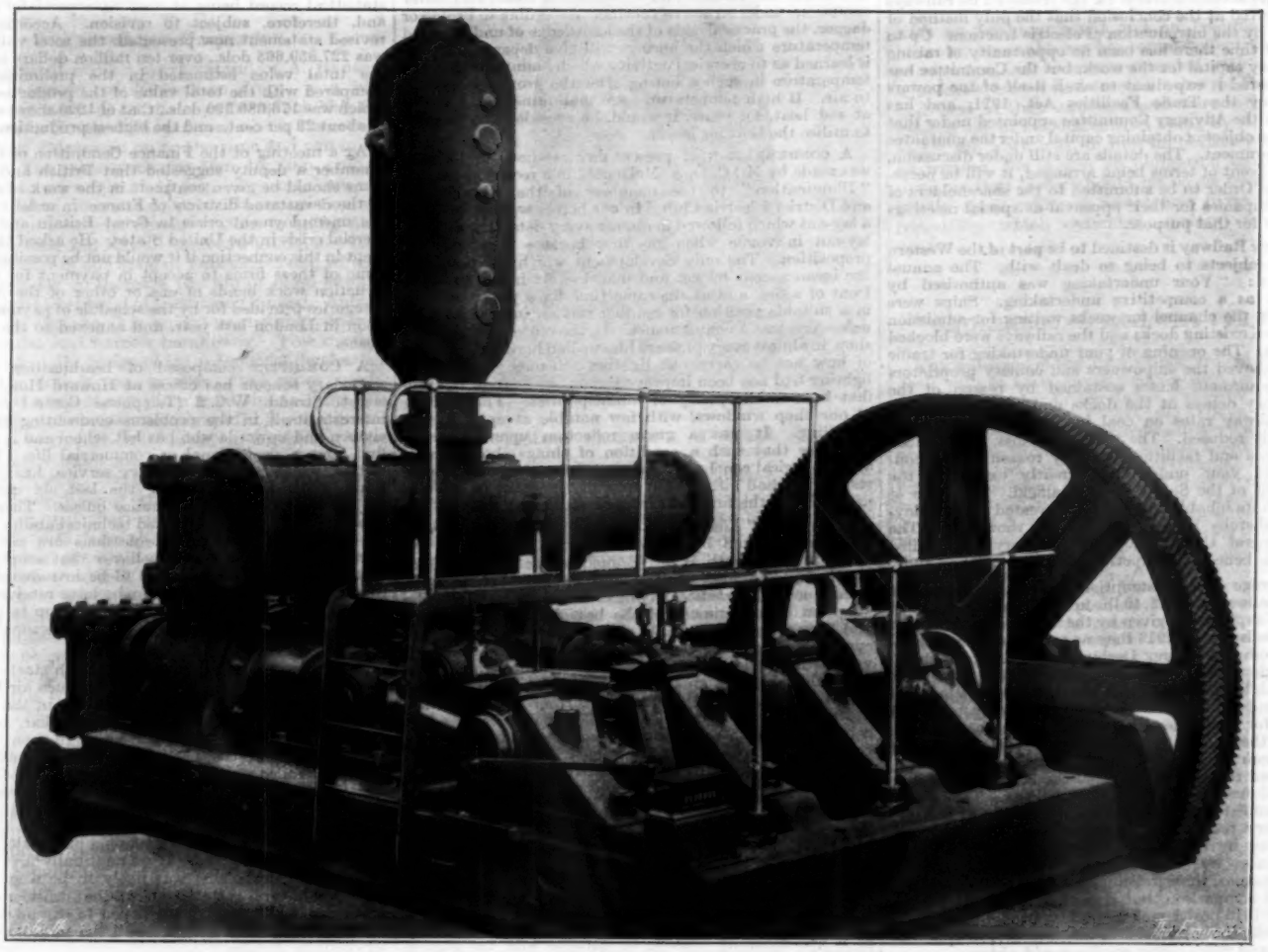
THE French aeroplane company which started and has made a success of the Toulouse-Casablanca air line is not only studying an extension of the line in the southerly direction down the western coast to Dakar, but is also anxious to extend it along the northern coast of Africa. The engineers of the Latecoere Company have already made a detailed study of the district between Casablanca and Oran; the support of Marshal Lyautey and of the Shereefian Government has been obtained, and it is hoped to open the first branch of the new extension, Casablanca to Oran, in June next. The stopping places along the line have not yet been fixed. It was naturally first necessary to ascertain if the line was likely to be a success, and inquiries, have, it is stated, shown that considerable traffic is assured. Eventually it is hoped to extend the line to Tunis, where it will link up with the projected seaplane service from Antibes to Ajaccio (Corsica), and thence across the Mediterranean to Tunis.

TREBLE RAM PUMPING PLANT FOR TRINIDAD

FRANK PEARN AND CO., LIMITED, WEST GORTON, MANCHESTER, ENGINEERS

(*For description see page 248*)





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By arrangement with Reuter's Engineering Service **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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DEATH.

JAMES MARSHALL, of Britannia Works, Gainsborough, on Monday, February 27th, aged 86 years.

THE ENGINEER.

MARCH 3, 1922.

Railway Brakes.

THE two papers read before the Institution of Civil Engineers on January 10th, on the subject of train brakes, raise a matter of considerable importance. We particularly welcome them as a means of stimulating thought on a detail of modern rolling stock which has not generally received the attention which it merits. The paper contributed by Sir H. Fowler and Mr. H. N. Gresley is perhaps, in a measure, more interesting than that presented by Mr. A. W. Rendell, chiefly because it contains a description of trials carried out in this country with the automatic vacuum brake, with special reference to the suitability of that brake for long goods trains; nevertheless, Mr. Rendell's paper is of considerable value, setting out as it does the characteristic features which should be embodied in a satisfactory form of continuous brake for railway service. We do not propose to contrast the vacuum and what we may term the pressure brake, for both have in recent years been brought to a high state of perfection. As Messrs. Fowler and Gresley point out, it is more than fifty years now since we realised the necessity of continuous automatic brakes for passenger trains. During this time we have gone through a period of evolution until we now have the Westinghouse and the automatic vacuum brake, of which the latter is, of the two, most used in this country. Up to the present we have not used a continuous brake for goods or mineral trains, though certain express goods trains carrying perishable products are so fitted, and it is to the question of fitting such trains with some form of automatic continuous brake that we would draw attention at the moment.

Whilst we believe all will agree that it is most desirable that goods trains should be fitted with a continuous brake in order that heavier loads may be run at higher speeds, it must be conceded that the problem to be solved is not easy. In the first place we have, as we have already stated, two distinct forms of brake in use, and each is entirely different in its component parts from the other. It would seem, therefore, that when the time comes for the fitting of goods cars with a brake, either the vacuum or the air brake will have to be adopted, for to fit both would be out of the question. In making this assertion we are aware that certain carriage stock on some of our lines, notably that employed in the Anglo-Scottish services, on both routes, is "dual fitted," but in such cases that is a relatively easy course to take, because vehicles so fitted can be kept to a particular service; but in the case of goods wagons such practice would be, to say the least of it, most inconvenient. So far as the fitting of passenger trains with a continuous brake is concerned, the problem is not difficult. In the first place, the close coupling of the several vehicles composing the train can be depended upon with a considerable degree of certainty, and further, the difference in the light and loaded weights of the cars is very small, amounting to only some 20 per cent. with normal loading. Again, express trains do not often exceed more than some 800ft. in length, and this fact, coupled with block pressures bearing a nominally constant relationship to the weight to be braked makes it possible to provide a smooth working brake. The case of the goods train is entirely different. The trains are both heavier and longer. The Great Northern 63-van test train probably exceeded 1000ft. in length, and a 101-van train would be about 1600ft. long behind the engine. Screw couplings would be necessary, and it is more than likely that in most cases they would never be really screwed up sufficiently to bring the vehicles buffer to buffer. Another point of great importance is the considerable disparity in the weights of the vehicles. Not only are they of diverse capacities, but some are loaded and others light, and this variation, together with the varying nominal brake powers adopted on different railways, makes the problem of providing efficient brake power difficult. In general, when goods cars are fitted with a continuous brake, they are braked to a comparatively high percentage of their tare weight, with the express object of obtaining a reasonable brake power when the vehicle is loaded. This practice, in some cases, has led to the adoption of abnormally high tare load braking, but, as Mr. Rendell remarks, proper rates of deceleration "can only be regularly secured if every wheel is fully braked to the extent of its adhesion under the most unfavourable conditions." This observation is of importance, for it points to the fact that block pressures often used are too high for efficient braking. Unequal brake powers throughout mixed goods trains are most undesirable, and the difficulties arising from this source cannot well be avoided with the form of brake, either vacuum or air, which is applied with success on passenger trains.

In the United States the Westinghouse Brake Company has introduced what is termed double capacity brake equipment, the arrangement being such that the brake power available for any degree of application is augmented when the car is loaded, and reduced when empty, so that the brake power percentage is equal, and has adopted, apparently, a brake power of 40 per cent., light or loaded, a figure which we think will fit in well with Mr. Rendell's ruling. We believe the braking of goods trains cannot be accomplished in a satisfactory manner without some form of simple and efficient double capacity brake equipment, for with the ordinary single capacity brake the shocks on the draw gear are of a most severe character, and unless reduced will make it impossible to provide a really commendable form of continuous brake for goods train service, no matter which system may be finally adopted.

Knowledge and Tradition.

KNOWLEDGE of technical matters is gained, broadly, in two ways. The older and most widely practised is that of experience or "trial and error." Here men learn "how to do things" by simply discovering, often in painful and expensive ways, exactly what it is profitable to do and what it is necessary to avoid. The method is, of course, capable of yielding very valuable and excellent results; the whole development of industrial technique in pre-scientific days must be ascribed to it. But it is by no means an ideal or satisfactory method, particularly when applied—as it often is—by those who have no knowledge or training in regard to methods of experimenting or investigating. Its progress is both slow and costly, and innumerable failures occur before success is attained. As a rule we encounter mainly the successful results of such a process of industrial development; the wreckage of the failures lies buried in the past. But even the "successful" results are far from being all that can be desired. In the most favourable case an industrial process or practice is evolved which serves to produce some special result in a manner which, for the moment, appears to be satisfactory. No one, least of all those engaged upon the operation in question,

really knows or understands the "why" and "how" of the business, and usually it is not known with any degree of certainty which parts of a process are really essential and effective and which are little better than "trimmings," possibly surviving from some previous and less successful phase of development. We, of course, exclude from this condemnation the ordinary progress of manufactured commodities, which advance by the trial-and-error method of everyday use. If inventors of machines or discoverers of materials waited for perfection before seeking a market, the world would never get on at all. Progress in such things must of necessity be, after the initial stages, slow and secular.

With the exception indicated above one obvious and serious consequence of a technique based on such a process of growth is that it is not readily adaptable. The pressure of events may demand a new or improved product or cheaper production, and the knowledge accumulated in the industry is not sufficient to provide what is thus required. Many instances have occurred where a flourishing industry has been destroyed by outside competition, simply for want of such powers of adaptation and further development. This limitation, however, although serious and dangerous, is not the only ill effect of this older method in technological progress. This method seldom, if ever, provides those who are engaged in it with any fundamental knowledge; the real explanations of what occurs are not accessible to them. But since the human mind demands some sort of explanation of its surroundings, "explanations" are invented. Reasons for various occurrencee are stated, often on flimsy or quite erroneous grounds, and are handed down in the industry and become traditional laws. Only quite rarely do these traditions have any real foundation in fact, but they are none the less firmly held by many otherwise apparently intelligent persons. One might mention, by way of an example, that it was for a long time generally accepted among certain glass makers that the presence of alumina in glass was necessarily extremely injurious. The mere fact that certain kinds of glass were being made elsewhere in which the presence of a considerable proportion of alumina was found to be essential, was not sufficient to shake the faith in this tradition, and the tradition thus actually became a serious barrier to progress. Scientific investigation showed the need for the use of aluminiferous glass for certain purposes, but the "accumulated knowledge" of the industry refused to accept or act upon such a finding. It was suggested, as it so often is, that this was a case where "theory" and "practice" did not agree. Actually, however, it was not the real knowledge obtainable from an intelligent and scientific study of practical operations which was at variance with scientific conclusions, but rather a false "theory" set up to explain the facts of practice. It is perhaps in this matter that the second method of acquiring technical knowledge contrasts most strongly and, at times, comes most strikingly into conflict with the method already described. This second method is the method of science, progressing by systematic inquiry and experiment, always directed to the elucidation of causes and the establishment of principles applicable not merely to a single operation, but to whole classes of operations. This method, it should be remembered, can be applied in practical working as well as in a laboratory; it is not so much a question of the implements employed—whether they be in the laboratory or in a factory—as the attitude of mind and the steady application of the principles of scientific investigation and reasoning. When technological processes are studied in this way, not only is it possible to arrive at the inner meaning—the operative causes—of what takes place, but a sound "theory" can be set up which makes it possible to expand and modify operations in order to adapt them to fresh requirements that arise from time to time. It must, of course, be realised that the application of scientific methods to the study of large-scale operations is often impossible for various practical reasons, such as cost and the inexorable demands of production. For that reason the greater number of scientific investigations are carried out on a small scale and in laboratories. None the less, the operations of Nature are the same in the laboratory and the workshop, and sound methods of investigation reach the same scientific conclusion by whatever path they arrive at it.

To a very considerable extent the value of the scientific method of extending knowledge in technical matters has, by this time, come to be recognised. To a certain extent the application of science to industry has even become fashionable, and we see so-called "research laboratories" in many industrial works. Sometimes the term is a gross misnomer, while in other cases the laboratory is regarded as a luxury, to be scrapped when financial stress arises. But even where this is not the case, those who seek to apply scientific results to practical industrial purposes find themselves frequently in conflict with what is called "established practice;" they are told that their "theory" conflicts with "practice." This is not merely the natural opposition of an unintelligent operative who opposes any change in what he has to do, but often the carefully weighed judgment of men of business who are sincerely and intelligently endeavouring to arrive at what is best for their purpose. Here we have one phase of the age-long battle between well-established tradition and new and seemingly revolutionary knowledge. We have cited above an example relating to glass, and it might be indefinitely multiplied. As an example that will appeal more directly to the engineer, we may take the "explanation" of failures resulting from fatigue or vibration stresses; such failure—traditionally—is still very widely stated to be due to the "crystallisation" of the metal. Now this "explanation" is an example of an erroneous theory set up at a time when it was not known that the crystalline appearance of certain types of fracture did not necessarily imply actual "crystallisation." To those conversant with the scientific study of the subject it is now, of course, well known that iron and steel, at all events, do not undergo any change of internal structure, under the effects of vibration or fatigue, which can possibly be described as "crystallisation," and that the crystalline appearance—or otherwise—of a fracture depends upon the manner in which the metal is broken. The whole story of the mechanism of failure under fatigue has not yet, perhaps, been told by scientific investigators, but a great deal of real knowledge of immense practical importance has been acquired, and the conclusions are used in their daily work by many engineers. Yet the old traditional "explanation" of "crystallisation" is still widely heard and may even be found in fairly modern books. It is a striking case of the manner in which tradition persistently opposes real knowledge.

Obituary.

R. B. SLACKE.

IT is with great sorrow that we have to announce that Mr. Randal Beresford Slacke, Manager and Publisher of THE ENGINEER, was killed in an accident in the hunting field on Tuesday last. He joined the staff of THE ENGINEER in the spring of 1919 to fill the place occupied for many years by Mr. Sydney White, and bringing to his work a long experience of commercial engineering, he had, in the few years he was with us, firmly established himself as an invaluable member of the staff. He was for some years manager of the London office of Messrs. Galloways, but left in January, 1917, to take a commission in the Royal Engineers, and after serving for a few months with Inland Waterways and Docks, he was lent to the Admiralty for duty as Deputy Assistant Director and Assistant Director of Materials and Priority.

Literature.

History of the Great War: Naval Operations, Vol. II. By Sir JULIAN S. CORBETT. London: Longmans, Green and Co. 21s. net.

THE second volume of "Naval Operations" carries the story of the war at sea as far as May, 1915, thus covering a period of six months, the first volume having closed with a description of the Falklands battle. The two outstanding events of the period in question were the Dogger Bank action, and the opening of the Dardanelles campaign, and both are dealt with as fully as their importance merits. Sir Julian Corbett again displays his talent for analysing an immense mass of data and presenting his conclusions in a narrative which is wonderfully clear and convincing. He is able to give us the first complete account of the German battle-cruiser raid on the Yorkshire coast in December, 1915, and its sequel on the Dogger Bank a month later. The general public has always supposed the raid to have come as a complete surprise to our naval authorities, and there were the usual murmurings at the Admiralty's supineness in failing to recognise and provide against the danger. Sir Julian, however, makes it clear that these strictures were undeserved. That the Germans were contemplating some offensive operation was no secret to Whitehall, and dispositions had been made to give them a warm reception. Admiral Jellicoe had previously explained in his book, "The Grand Fleet," how the enemy, favoured as he so often was by the vagaries of North Sea weather, contrived to escape the snare which had been laid for him. On their return voyage after bombarding Scarborough and Hartlepool his ships had the narrowest possible escape from being intercepted by Admirals Beatty and Warrender. It was touch-and-go in the mist which descended over the scene at the critical moment, "a chance of the sea beyond human calculation." Our ill-fortune held to the last, for a gallant attack delivered by one of our submarines was frustrated by the erratic running of the torpedo. Encouraged by the immunity they had enjoyed on the first occasion, the Germans planned a second raid, this time on Sunderland, but again the Admiralty got wind of the scheme and took the necessary measures to baulk it. The German battle-cruisers, under Admiral Hipper, were sighted at dawn on January 24th, and there ensued the running fight which is known as the Dogger Bank action. Hours of steaming at high speed were necessary before Admiral Beatty could get within range of the flying foe, and, as always, "the response of the engine-room was magnificent." When the Lion and her consorts had worked up to 26 knots the Admiral called for 27. This was 2 knots above the mean trial speed of the Indomitable, yet she kept her place in the line, and received from the flagship the congratulatory signal, "Well steamed, Indomitable." The New Zealand also steamed admirably, "but every man in the engine-rooms knew it was the chance of a lifetime, and all that men could do they did." How, foot by foot, our ships overhauled the enemy, and how their big guns knocked out the Blücher and inflicted terrible injury on the Seydlitz, is an old story now. But Sir Julian throws new light on the incidents of the battle and its somewhat disappointing finish. Owing to a misunderstanding of orders, the fire of the British squadron was not distributed as effectively as it might have been, and the Germans were enabled to concentrate their salvoes on our flagships. As a consequence, the Lion received heavy punishment, and successive hits caused damage, both direct and indirect, which finally compelled her to drop out of the chase. When this happened, Admiral Beatty signalled his second-in-command to "Keep closer to the enemy" but the wind blew the flags end on to the other ships, and this all-important signal was not taken in. Instead, therefore, of continuing the pursuit of the already beaten enemy, our ships hauled off and contented themselves with completing the destruction of the Blücher. From Sir Julian's reading of the facts there is little doubt that the German squadron would have been wiped out had the pursuit been pressed. Apart from those on the Blücher, the worst hit received by the Germans was scored on the Seydlitz when a heavy shell struck her on the quarter deck and disabled both the after turrets, the entire crews of which were killed. The indirect damage which a shell-burst may cause was exemplified by a hit on the Lion. An 11in. shell pierced her armour. The engineer's workshop was flooded; the water spread to the open switchboard compartment, short-circuiting two dynamos, disabling the after fire-control and secondary armament circuits, and causing the ship to list to port. Another shell smashed in the armour below the water-line, causing so great a shock that at the moment it was thought a torpedo had exploded. The decisive hit was made by a shell which drove in the armour on the water-line in way of one of the boiler-rooms, doing so much damage to the feed tank and inside the engine-room that the port engine had to be stopped. The exact number of hits received by the Lion is not stated, but it must have been high. On the other hand, we had left our mark on the enemy, for besides the sinking of the Blucher, the damage inflicted on the Seydlitz and the Derfflinger was very severe.

The chapters on the Dardanelles campaign are of enthralling interest. It is by no means easy to describe a protracted operation, amphibious in character, without sacrificing lucidity or chronological sequence, yet Sir Julian accomplishes the task with perfect success. The impression left by his account of the great attack on March 18th is that failure was practically a foregone conclusion. It seems certain that the strength of the defence had been underrated. Ships must always be at a disadvantage when engaging forts, but in the case of the Dardanelles the odds against them were exceptionally heavy. There the ships had to contend not only with fixed defences—mainly obsolete in design, no doubt, but mounting a large number of big guns which were terribly effective at medium range—but with mobile guns and howitzers firing from hidden positions, and, worst of all, with anchored and floating mines, the latter type being by far the most dangerous. That our losses in the great attack were heavy is not surprising. The wonder is that they were not infinitely heavier. There was, as we know, some talk at home of repeating the assault and pressing it to a decision. We cannot believe that those who urged this course were fully informed as to what had happened on March 18th. Of the sixteen capital ships engaged, three had been sunk and three totally disabled for an indefinite period, so that one-third of the Allied battle-fleet had been expended in an operation lasting only a few hours. True, the enemy had also suffered; his forts had been

badly knocked about, and his casualties were not light. But most of the guns remained in action; ammunition, though short, was not exhausted, and judging from the excellence of the shooting up to the last, the *morale* of the garrison remained good. Even had our ships contrived to master the forts, they would still have had to negotiate five big minefields before getting through the Narrows. It was calculated on authority that the chances of passing these obstructions would have been 15 to 1. The great naval attack of March 18th was an epic of audacity and dauntless courage, but the soundness of the strategy which inspired it must always remain open to question.

The beach landings of the Expeditionary Force on April 25th are described with a wealth of graphic but strictly relevant detail. As a story of superb herosim it will endure as long as the English name. Here is one of the author's vivid pen-pictures:

"Down a hollow in the ground were seen a mass of men moving at the double from the direction of the enemy. Some thought they were Turks—some that it was our men retiring. They were a splendid target, and the Queen Elizabeth had two of her 15in. guns loaded with shrapnel. As each shell could throw 13,000 bullets, a fair burst would be the practical annihilation of the moving mass and go far to decide the day. But were they friends or foes. It was for the General to decide. The temptation was great, but the appalling results of a mistake were not to be easily faced. There was scarcely a doubt they were enemy, but while there was a grain of doubt he could not give the word, and before he was certain the mass was out of sight. The question was soon settled. It was a mass of enemy that had so narrowly escaped destruction." But the Turks, unwitting of the danger from the sea, soon repeated the charge. "Another rush brought the enemy's line to a point where the flagship exactly enfiladed it. Then a 15in. gun spoke—the shell burst fifty yards from the enemy's right, and when the smoke cleared there was not a man to be seen."

In addition to the major events thus chronicled, the historian deals at adequate length with all the operations which took place in the naval theatre during the period under review. Thanks to his attractive style and obvious command of the facts the narrative never flags, but carries the reader on from phase to phase until the end of the volume is reached. Naval students may not always accept Sir Julian's conclusions, but we think there will be general agreement as to his qualifications for the monumental task on which he is engaged, combining as he does a profound knowledge of naval history with a sufficient grasp of modern technique. The appearance of the third volume, which is to include, *inter alia*, the beginning of the German extended submarine campaign and the battle of Jutland, will be eagerly awaited.

Engineering Steels. By LESLIE AITCHISON. Macdonald and Evans. 25s.

ATTENTION has been previously directed to the shower of specifications which were accepted with remarkable amiability by steel makers and engineers during the war period. As old specifications were being superseded continuously by new ones it is fair to assume that the specification makers were learning all the time. Had similar circumstances continued, they would no doubt be still busy. But much may be learned in four years by the most empiric methods of fingering the Empire's metallurgical and engineering resources, and we are naturally interested to know by how much the privileged officials are wiser. They are under no compulsion to satisfy our curiosity, and on that account we are the more indebted to Professor Jenkin for a report on "Materials of Construction Used in Aircraft," and to Dr. Aitchison for his book on "Engineering Steels" which lies before us. These two men were respectively Director and Assistant of the Materials Section of the Technical Department of Aircraft Production, and were responsible for specifications and amended specifications governing the supply of materials Professor Jenkin's report shows evidence of his endeavour to reach through preconceived notions and traditions to fundamental principles; and many for whom it is not especially intended will read Dr. Aitchison's book, hoping to find an exposition of organised common-sense ideas evolved by acute experience and confirmatory experiment from the relative chaos and costly traditions which ruled in 1914.

The first four chapters deal with Steel Melting Processes; The Casting and Working of Steel; The Heat-treatment of Steel; and Mechanical Testing of Steel. Adequately treated in this order they do not lead to the conclusion that the quality of steel as Professor Unwin affirms in a foreword "depends primarily on its chemical composition." They show rather that the melting process and the casting of the ingot confer qualities on steel which in a modified form persist through all working and heat-treatment operations, and cannot be measured by methods of chemical analysis or the usual mechanical tests. Such qualities are always important and may be vital.

Dr. Aitchison's object is "to provide the information which it is considered the engineer should possess to enable him to understand the steel he is using." To do this the author must perforce describe variants in steel-making processes. These descriptions are adorned by harmless fictions, such as the invention of cast steel by Huntsman because better springs were required in his clock-making business; and there are occasional details of furnace work, ingot making and factory procedure which would be contested by specialists in these lines. These, however, are minor blemishes, and it is more to the point to note that Dr. Aitchison's statements of the effects on steel of the melting, casting and forging processes are on well-reasoned lines. He puts conclusions to engineers in forceful language which the least imaginative should understand. As an example, let us quote his summary of the results of hot casting and the formation of chill crystals in ingots. He says, "By reason of the fact that each columnar crystal has started to grow around a different axis, each columnar crystal can be accurately conceived as being a separate and distinct entity, and as possessing comparatively little cohesion with its neighbours. This applies both to the contact between the sides of contiguous parallel crystals and also to the 'point' contacts at the ends of the crystals of different sets, *i.e.*, those growing from different sides of the ingot mould. Probably, in the latter region, the lack of cohesion is more marked than in the former, since the columnar crystals, in growing forward into the fluid metal, tend to squeeze out the foreign matter from between them and to push it forward into the ingot so that it collects at the front ends of the columns. There are, therefore, definite planes of weakness which lie diagonally in the ingot wherever the crystals are columnar. One exactly similar zone exists, of course, all round the pyramid (truncated or complete) which forms in the bottom of the ingot. All these positions, therefore, mark the existence, within the ingot, of planes or zones of weakness in which the inter-crystalline cohesion is at a minimum. The planes and zones of weakness within the ingot are of great importance because they become the centres of certain definite defects of greater or less dimensions. The properties of the original ingot, in a very large proportion of instances, decide whether the steel part used by the engineer is good or bad."

If Dr. Aitchison intends to act as a guide in the selection of steel then all parts of his book should converge in his views on the testing of steel. The engineer must ultimately ask for what he wants and see that he gets it by specifying properties which can be weighed or measured. The raw material of all specifications is knowledge and experience; the quality or efficiency of a specification depends on the wisdom with which these factors are applied to ensure suitable material without enforcing useless restraint on the contractor. Of those mechanical properties usually specified the maximum stress survives in Dr. Aitchison's conclusions as an indirect means of determining the fatigue range of a steel and the notched bar impact test survives in its own right. The elastic limit and yield point of steel are both dismissed as indeterminate quantities in some large classes of steel and of small practical use in any case. The elongation per cent. is regarded as a measure of ductility, but though ductility is praised beyond its deserts, neither this property nor the reduction of area per cent. are allowed to be of real value. It is clearly stated that the fatigue range of a steel from limiting stress to limiting compression is practically equal to the maximum stress. This statement is not always supported by figures given in the text, but accepting it as being generally true, then surgical criticism reduces the useful commercial testing appliances to a ball-hardness testing machine, by which the maximum stress or fatigue range is indirectly determined, and an Izod impact testing machine. It should be said that Dr. Aitchison's equipment would also include regular sulphur prints or occasional macro-etchings to ensure the engineer against those defects in ingot making which no form of mechanical test pretends to detect. The author states his conclusion thus:—"Of two steels which are available for any particular job, both of them giving the required tensile strength, the one which should be used, other things being equal, is the steel which gives the best impact value."

Dr. Aitchison's destructive criticism could hardly be exercised on a riper subject than the mechanical testing of steel. If his views were the expression of an opinion unsupported by evidence or were tainted by self-interest they might pass unnoticed. As reasoned conclusions they will be re-examined and criticised in turn until ultimately we may get simpler or better or cheaper methods of testing. Here and there he reaches conclusions without giving reasons, and sometimes even against apparent reasons. This he may do from lack of space or just because he likes "trailing his coat." Yet either attitude, though harmless to the critical reader, is apt to unsettle the student who is beginning to shape his ideas and is, moreover, not in harmony with the object of the volume.

The ill-effects of mass are argued and illustrated by considering only the mechanical properties—particularly the maximum stress—of hardened bars. As a matter of fact alloy steels, to which the arguments apply, are mainly used in the hardened and tempered condition. In that condition a consideration of mass effect would show that the author's distinctions are empirical and much less valuable than they appear to be when hardened and untempered steels only are used as a basis of comparison. This fallacy leads to an emphasis on the value of nickel-chromium steel which is much beyond their desserts. For purposes requiring a maximum stress of 60 tons or over Dr. Aitchison thinks only in terms of nickel-chromium steels. When the required maximum stress falls between 50 and 60 tons he admits chromium or chromium-vanadium steels and only when the required maximum stress is below 50 tons does he recommend nickel steels. On metallurgical grounds this advice is of doubtful merit; on economic grounds it is likely to be ruinous. The author adds his testimony to the growing belief that the really valuable alloy in chromium-vanadium steels is the chromium. Belief or scepticism on this point can be replaced by conviction in the mind of any person who will take the trouble to test a comparative series of bars of chromium steel, with and without vanadium, which, after hardening, have been re-heated to definite temperatures in an ascending series.

Dr. Aitchison's book may be heartily welcomed as an engineering text-book. It deals with the important subject of selecting the right steel and testing it by effective means which are simpler and less costly than those in current use. Its value lies less perhaps in the conclusions reached than in the methods used, *i.e.*, in the detailed evidence and arguments on which the conclusions are based. These conclusions will not be unanimously accepted, the author himself will undoubtedly modify them in any later edition which may appear; but for the first time we have a work which attempts to deduce logically from experimental facts what has previously been settled by tradition and lame analogy.

BOOKS RECEIVED.

The Microscope. By Conrad Beck. London: R. and J. Beck, Limited, 68, Cornhill, E.C. Price 2s. 6d. net.

Applied Geography. By A. Stevens. London: Blackie and Son, Limited, 50, Old Bailey, E.C. 4. Price 6s. net.

Mechanical Appliances for Handling Railway Traffic. By George Bulkeley. London: *The Railway Gazette.* Price 5s. net.

Converting a Business into a Private Company. By H. W. Jordan. London: Jordan and Sons, Limited, Chancery-lane, W.C. 2. Price 1s. net.

Electrical Installation Rules and Tables. By W. S. Ibbetson. London: E. and F. N. Spon, Limited, 57, Haymarket, S.W. 1. Price 1s. 6d. net.

Cotton-spinning Machinery and its Uses. By Wm. Scott Taggart. London: Sir Isaac Pitman and Sons, Limited, Parker-street, W.C. 2. Price 2s. 6d. net.

Railway Signalling. By Everett E. King. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 20s. net.

British Rainfall, 1920. The sixtieth annual volume of the British Rainfall Organisation. London: His Majesty's Stationery Office, Imperial House, Kingsway, W.C. 2. Price 12s. 6d. net.

Coalition Government: A League of Parties as an Efficient Method of Government. By O. F. Maclagan. London: Purbrook and Eyre, 98A and 98B, Old-street, E.C. 1. Price 2d.

Graphical Analysis: A Text-book on Graphic Statics. By W. S. Wolfe. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 20s. net.

Market Analysis: Its Principles and Methods. By Percival White. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 17s. 6d. net.

Graphical Methods for Schools, Colleges, Statisticians, Engineers and Executives. By W. C. Marshall. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 18s. net.

The Modern Motor Truck: Design, Construction, Operation, Repair, Commercial Applications. By Victor W. Pagé. London: Constable and Co., Limited, 10–12, Orange-street, Leicester-square, W.C. 2. Price 34s. net.

The Metallurgy of the Common Metals: Gold, Silver, Iron (and Steel), Copper, Lead and Zinc. By L. S. Austin. Fifth edition. London: Chapman and Hall, Limited, Henrietta-street, Covent Garden, W.C. 2. Price 42s. net.

Department of Industries, Bombay Presidency. The Vegetable Oil Industry in the Bombay Presidency. By A. F. Yuill. Bulletin No. 3 London: The Indian Trade Commissioner, 60, Winchester House, 1, Old Broad-street, E.C. 2. Price 2s. 9d.

The Manufacture of Cane Sugar. By Llewellyn Jones and Frederic I. Scard. Published under the auspices of the West India Committee. Second edition. London: Duckworth and Co., 3, Henrietta-street, Covent Garden, W.C. 2. Price 25s. net.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 6: Synthetic Phenol and Picric Acid. London: His Majesty's Stationery Office, Kingsway, W.C. 2. Price 15s. net.

"Proceedings" of the Royal Irish Academy, Vol. XXXVI., Section A, No. 1. T. Alexander and J. T. Jackson. *On Polygons to Generate Diagrams of Maximum Stress on Girders due to Locomotives and Dead Loads,* together with *An Extension of Rankine's Conjugate Load Areas to the Design of Masonry Arches.* Dublin: Hodges, Figgis and Co. London: Williams and Norgate. Price 1s. net.

Institution of Mechanical Engineers.

At a meeting of the North-Western Section of the Institution of Mechanical Engineers, which was held on the 23rd ult., Mr. Wall read his paper on "Electric Welding," Mr. Charles Day being in the chair.

Mr. Stromeyer, who opened the discussion, said that the development of electric welding had been hampered by the trade unions. He knew of an instance of a vessel on the Tyne, which, although it had been started, could not be finished owing to trade union regulations. With regard to the all-welded ship, the Fullagar, it was very gratifying that that vessel had stood the test of heavy weather with a cargo which produced severe stresses. It was, he continued, mentioned in the paper that by reducing the scantlings of a ship a reduction in the whole weight would be effected, but although that was a very desirable object to aim at, it would mean re-designing ships altogether. Mr. Stromeyer was with Lloyd's Register in the early days of steel, when it was realised what wonderfully good properties that material had as compared with ship iron. Iron plates would just stand punching, but not bending, and therefore could only be used for the flat parts of the ship. In spite of the change from that very bad material to mild steel, Lloyd's found that the reduction of 20 per cent. in the plates was too much. Although that was not admitted at first, gradually ships built under the first set of rules had to be stiffened, and the new ships were made with thicker plates. The need for plates thicker than what was hypothetically required was due to the wave action. A notable example of that was a Russian ship built by a man who had evidently got a contract which enabled him to do what he liked. He spaced the frames 4ft. apart instead of 2ft., and used very thin plates, his excuse being that as the vessel was flat and large the plating would not be subject to wave action. But when the vessel got out and into the Bay of Biscay, the plates slammed, and after putting into a Spanish port, she slowly got round to the Black Sea, but was never used again. When welding was used generally, some modification would have to be made in spacing the frames if a reduction in weight was aimed at.

Mr. Stromeyer mentioned that some years previously he had fitted strain indicators on board torpedo destroyers to make experiments, and found that strains registered by the instruments agreed very closely with the strains which calculation showed ought to exist, thus confirming naval architects in the correctness of their views. No further experiments had been made, but there were many parts of the structure of the modern battleship which deserved careful study. He had, he said, always taken an interest in strains in ships, and drew attention to the remarks in the paper about riveting of ships, in which the author took it for granted that all ships had their vertical seams lap jointed. That was the case, but in 1880 the ships then built had plates riveted with single butt straps. He had made experiments with strain indicators placed above or below one of these internal butt straps and obtained quite distinct readings, showing that there were very considerable strains just above and below the butt strap. In the middle of the plate, however, no readings could be obtained, which confirmed the theory that a single butt strap was strained about seven times as heavily as the plate itself. That could be calculated if the bending strain in the butt strap and in the plate were taken into account. This severe straining was very likely the cause of leakage at butt straps, a fact which could be demonstrated by a simple experiment with a strip of paper shaped like a single butt strap, with the ends of the strip reduced to one-seventh the width of the strip. When this strip was placed between two pieces of glass and subjected to stress, it did not tear at the thin ends, but through the butt strap. The effect of that experiment was that lap joints were used instead of single butt straps. It was very desirable that, if electric welding still further reduced strains, it should soon come into regular use. Mr. Stromeyer had every confidence in electric welding carried out by good men and with good material, and although he had heard of failures with acetylene welding, he did not know of any where electric welding had been used. Boilermakers seemed very fond of the latter method. He knew of cases of patches of corrosion 3ft. or 4ft. square, in which it was thought cheapest and best to fill up the defective parts by means of electric welding, and although he did not really approve of that method, the boilers so treated had worked quite satisfactorily after being repaired.

Mr. Stromeyer said he did not regard the training of welders as very essential, as electric welding was not a very difficult matter. He thought that an ordinary sensible worker with an aptitude for that class of work would very soon learn to do it, and as the operation was not very hard, he did not see any justification for the high prices charged for electric welding. He hoped that the trade unions would allow electric welding to be continued and not lead to its being forced into channels leading the wrong way. It was much harder to unlearn what welders had already learnt than to train them in the right way at the beginning. With regard to the saving of weight in battleships, the author stated that every ton saved on any particular item resulted in a total saving of 3 tons. He did not understand this, and asked the author to explain it.

Mr. Strawson said that a line in the author's first paragraph, which ran, "Reference is also made to the necessity of taking reasonable precautions in carrying out the work," was the keynote of successful welding. One of the first and most essential points to watch, so as to avoid poor quality welding, was that the source of electrical supply was always capable of giving more than sufficient current to cope with the maximum demand of the welder or welders on the work in hand. It was also necessary that the method of regulation should be such that as constant a voltage as possible was ensured under all conditions. The voltage should not under any circumstances be on the high side, as with a high voltage there was more chance of welding with a long and flaming arc, which made it difficult to control the too fluid metal, while at the same time oxide was incorporated in the metal and gave a hard and brittle weld, which was the most undesirable possible condition. The arc should be the shortest possible that would give an even flow of metal. It was very difficult to get the non-technical welder to realise that there was a speed of working for each individual weld that must not be greatly exceeded. It was governed by the type of joint, the thickness of metal, the size of the electrode, and the quantity of current used, the two latter factors being governed by the two former. Some welders only produced average welds because they did not pay sufficient attention to the size of electrode for the work in hand, often choosing one that was too small and attempting to pass through it a current that was too heavy for it to carry. As a consequence, the flux was semi-fluid before it reached the point of contact with the metal being welded. That tended to incorporate slag under the weld, while at the same time it was not possible to pass sufficient current properly to melt the relatively heavier metal to be welded. The welder would be well advised to adjust the current by the actual flow of metal by trial, rather than by consulting somebody's "Handbook for Welders" as to what was the correct current for a given electrode. The matter of the electrode itself was one which must not be overlooked. In that direction there was too much prejudice shown. One firm would only use one type of electrode; another firm would swear by a different type, instead of each firm keeping a supply of all the well-known and reliable makes and using them in accordance with what was required on the particular work in hand. To use one type of electrode for all work was a great mistake, and likely to lead to biassed opinions that were not helpful to the furthering of the cause of welding. It was surprising, he said, what strength was obtained on an average weld when tested to destruction, and he exhibited some examples of welding of metal picked off the scrap heap and welded up without even the rust being cleaned off. They had, he said, been tested to a much greater stress than they would have been subjected to if forming the part of a structure. Several of these samples had been constructed on similar lines to details given in Mr. Wall's paper. There were three points upon which Mr. Strawson disagreed with the author. First, that it was not possible to train an efficient welder in two months' time to undertake every type of work that came along; and, secondly, that edges that had been oxy-cut did not allow good arc welds to be made. If the oxy-cutting was fairly good and the oxide knocked off the edges of the plate, using the correct electrode solved that problem every time. Thousands of feet of oxy-cut edges were welded in Manchester every week, and the vessels and tanks constructed were tested to anything up to 850 lb. per square inch. Many hundreds of them had been working for several years in all parts of the world, and up to then not a single one had been returned as defective. Thirdly, in Mr. Wall's remarks regarding welding with bare wire, he possibly was not aware that the whole of the damage to the German ships which were mutilated in American seaports during the war were rectified by bare wire welding by the Wilson arc system. That, however, necessitated a rather costly plant, and the wire used was not ordinary wire, but a patented alloy which could only be used with the Wilson plastic arc welding plant, which gave a constant voltage and a regulated constant current, ensuring a uniform critical heat at the weld. Nevertheless, some wonderful results had been obtained by that system, and railway tanks were being welded in England by it, and were quite successfully passing the Railway Clearing House inspector's requirements. It was not, however, as neat as welding done by a fluxed electrode. In the face of this, Mr. Strawson regretted that he had to differ from Mr. Wall. The saving of weight by welding was a factor well worth noting. Surface condensers up to about 10 tons in weight, made from mild steel plate, and rolled sections were quite frequently being made both for land and naval service in place of cast iron tanks of twice that weight, with a consequent saving of pattern making and the usual risks in making large and intricate castings. The time of manufacture was also halved. The attitude of some of the insurance companies was not too helpful to welding, chiefly owing to prejudice on the part of their older inspectors, who preferred the methods of fifty years ago to those of the present day. The larger companies accepted it as an accomplished fact, and the Railway Clearing House alternatively specified welded tanks for oil conveyance on the railways, the first tanks of this type being built in Manchester.

Mr. Gass, the next speaker, had not had any practical experience of electrical welding, but wished to obtain information as to the best method with the idea of doing this work himself. He thought that if it was possible to do everything the author stated by electric welding, the method had a great future. Whether it would reduce the cost or not was a question that could only be settled by actual experience, and that would be the point that would decide whether it would become extensively used or not.

Mr. Adamson thought that a point to bear in mind when bringing up the question of riveted joints *versus* electric-welded joints and seams was that the former had been developed after many years' practical experience, whereas the latter was a comparatively new method. It was certain that riveted joints slipped at a very low percentage of their ultimate strength, frequently causing leakage. He cautioned people against using electric welding where it was subject to severe bending or shock. More confidence in this method was necessary before it could be used for internal pressures, where failure would be disastrous to life and property. The American Society of Mechanical Engineers was giving very considerable attention to the application of electric welding to boiler construction. Although in America they had not had the lengthy experience of boiler construction that we had had in this country, they had developed a code which had proved very useful to the American Board of Trade, and which he thought was worthy of careful attention. He believed that the rapid adoption of electric welding in preference to acetylene welding was due to the greater ease with which men could be trained to do electric welding satisfactorily. In one concern which, for trade union reasons, had had to discard the use of acetylene welders during the war, electric welding had been adopted because it was realised that to train new men would take years, but by adopting electric welding the work could be carried on with very little delay.

Mr. Adamson remarked that it was the first time in a paper before the Institution that the difficulties raised by trade unions in the introduction of a new method had been referred to specifically, and he thanked the author, as an impartial witness, for making the reference. Although the prejudice perhaps was only natural, it did not tend to rapid progress in a new method.

Mr. Roberts stated that he agreed with Mr. Wall on all points except one, that being the author's condemnation of resistance welding. He had used this method extensively for spot welding fans for motors. Although the parts welded were under great centrifugal force, they were simply fastened by two or four spots, according to the size of the fan. A number of tests had been taken on spot welds, and it was found that the weld was quite homogeneous. Mr. Roberts mentioned the case of an American all-welded ship which was crushed in between a quay side and another vessel, 18in. in the width, without springing a leak. By some means it was straightened out again, but the welds remained quite sound, and there was no leaking shown at all.

Mr. Boswell said that a great deal of the success of welding depended on the human element. With regard to the training of welders, the actual job did not take very long to learn, but it was necessary to know something about it. Mr. Boswell asked whether electric welding was affected by wet weather, as in riveting it was necessary to wait until the joints and seams had dried before proceeding with the work. He also asked how far under the plate lap welding extended.

Mr. Burslon stated that electric welding could be applied equally well to cast iron and cast steel work, and when one article was required, was cheaper than riveting. The latter method was cheaper, however, if a number of castings were required. With regard to alternating stresses on steel bars electrically welded, Mr. Burslon mentioned the case of a heavy tractor which had been in service for a long time when the front axle broke across the centre. This axle had then been electrically welded and was working very satisfactorily, the tractor carrying loads of 8 or 10 tons over rough cobbled roads daily.

Mr. Wall said he was very glad Mr. Stromeyer had opened the discussion, as he was one who had very considerable experience in ship construction. In electric welding it was very easy to scamp both the output and the quality, and that had been done very often. With regard to elasticity, he did not think there was any difference between the welded ship and the riveted ship, up to the point at which the riveted joint really slipped, as distinct from holding and moving under stress and strain. Both welded and riveted joints behaved in exactly the same way, and unless it was assumed that the latter had a nasty habit of slipping, the proposition was not very different. The reduction of scantlings was a very vexed question. It was impossible to reduce the unsupported area or the thickness of plating indefinitely. The stiffeners necessary had to be considered, and in this connection welding was much easier and cheaper than riveting. With regard to the "slamming" of the bottom of the Russian ship, a similar case had occurred in a large battle-cruiser during the war, in which the bottom was very severely damaged by slamming, but the defect was remedied

by extra stiffening. Much more could be learnt from a failure like that than from an entirely successful experiment. It was well known that it had been found from experiments by Mr. Stromeyer and others that the strains in ships were not as great as those shown by the standard method of calculation. It was possible to build and run ships successfully with very much smaller scantlings than would be allowed in the ordinary way by Lloyd's Register. With regard to the initial saving of 1 ton resulting in a total saving in the weight of the ship of 3 tons, Mr. Wall explained that if it were decided to cut down superstructures on the deck or have a couple of guns less, the power for driving the ship could be made less, and therefore the engine weight could be reduced; as the engine weight was less there would be a further saving in power, and consequent saving in fuel. In fast destroyers it was possible to have a total saving of 5 tons for a saving of 1 ton on one item.

A Friction Drive for Rolling Mills.

A NEW form of driving arrangement for rolling mills has recently been patented and put into use by Mr. T. B. Rogerson, managing director of James Dunlop and Co., Limited, Glasgow, the owners of the Clyde Ironworks and the Calderbank Steel Works. The drive makes use of friction rollers instead of the ordinary gearing between the engine and the mill, and is especially suitable for plate and sheet mills, although no doubt it could be applied to other forms of mill if suitable arrangements could be made. The example illustrated herewith is to be found at the Calderbank works, but we understand that Messrs. Colville, of Motherwell, and Cockerill, of Seraing, have also installed Mr. Rogerson's drive for one or more of their mills. The Calderbank works, it may be said, have previously attracted attention in the matter of driving rolling mills by virtue of the fact that one of its three-high plate mills is coupled through gearing to a Parsons steam turbine working normally on the exhaust from the cogging mill engine and the engine driving the two-high plate mill to which the friction drive is applied. In the event of the supply of exhaust steam being insufficient to maintain the speed of the turbine, a governor is arranged automatically to admit live steam from the boilers.

As applied to the two-high 38in. reversing plate mill at Calderbank, Mr. Rogerson's drive consists of two rollers about 4ft. long arranged one above the other in a suitable housing. The lower roller is connected to the engine shaft and to the lower roll of the mill. The upper roller is connected to the upper roll of the mill through a flexible shaft and simply rests with its own weight on top of its fellow. The friction rollers may be made of cast iron or cast steel or may be formed from used-up mill rolls. They are turned with a finish similar to that given to ordinary mill rolls. That the friction between the rollers should be sufficient to drive the upper roll may appear surprising. It is, however, ample for the purpose, and by suitably choosing the length of the friction rollers it can be arranged that slipping shall not take place until the resistance to the drive rises approximately to a set abnormal value. When the mill is being started up and the lubricant in the journals is cold, it is sometimes necessary to increase the frictional grip of the rollers by throwing sand between them. Otherwise no assistance is required to prevent slipping in normal working. Should a jamb occur, the rollers will of course slip and by so doing will avoid the breakage of the driving connections which is the usual result of a jamb with ordinary gearing. The wear on the rollers after several months' use is, we are informed, found to be very small.

In devising this form of drive, Mr. Rogerson was primarily aiming at the avoidance of delays caused by breakdowns. It has now, however, been established that in addition to securing this object there is a distinct saving in first cost in favour of the friction drive as compared with the ordinary drive by means of cast or forged steel pinions, and that much less lubricant is required. Of still greater importance, however, is the fact, found by experience, that the adoption of the friction drive has increased the life of the mill rolls. From some figures supplied to us relating to the lives of ten rolls operated by pinion drive and of nine rolls operated by Mr. Rogerson's friction drive, we find that the best of the first-named broke after it had rolled 26,722 tons of material, while among the latter, one is returned as still being in use after having rolled 44,282 tons; another broke through wear and tear at 39,954 tons, and a third reached 39,450 without failing. Even more significant perhaps are the figures relating to what were obviously defective rolls. Among the pinion-driven rolls one cracked in the centre during the third shift at 1203 tons, and another broke through the neck at 4451 tons. Among the friction-driven rolls three were admitted by the makers to be defective by reason of faulty chilling. These three rolls are returned as still being in use after having rolled 29,053, 28,126 and 4052 tons. As an example of the effectiveness of the drive in preventing serious damage, it may be said that on one occasion of which we have particulars a three-ton slab was being rolled down from 8in. to $\frac{3}{4}$in. in thickness when a guard became caught between the plate and the rolls. Instead of the mill or engine or both being seriously damaged, as would almost certainly have occurred had the drive been of the usual pinion form, all that happened was that a delay of not more than two minutes occurred.

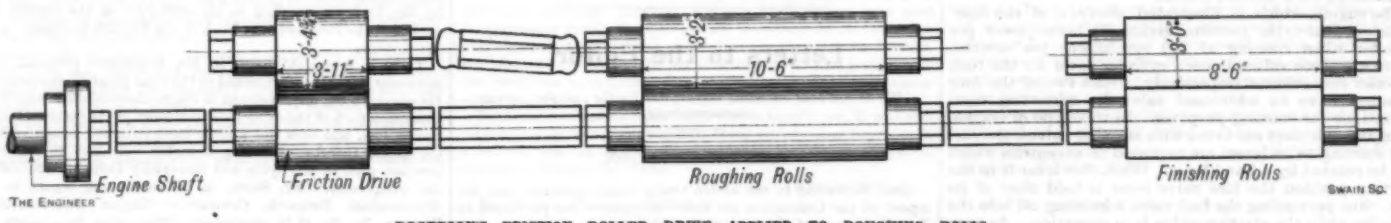
TWO-HIGH REVERSING PLATE MILL FITTED WITH FRICTION DRIVE

The author regarded Mr. Strawson's remarks as very interesting, as he spoke from a practical point of view. With regard to voltage, 60 volts pressure was frequently used, and gave perfectly satisfactory results. After being cut by acetylene flame, the metal was affected some distance in, and was not a good foundation for electric welding. Bare wire welding was looked upon as retrograde practice. Flux-covered electrodes had made great advances, and had it not been for them, it would not have been possible to construct the Fullagar. Overhead welding could be done with a good flux-covered electrode, although a good deal was bound to drop down. He had made a number of shock tests on welds, and though they were fairly severe and eventually bent the plate, the weld did not break. Joints should be carefully designed, keeping in view the work they would have to do. In a V butt weld, if the plate was to be bent so that the weld was on the outside of the joint, very severe strains would be caused, and it would be necessary to reinforce the weld in some way. In his experiments he had found that electric welding really withstood alternating stresses much better than he anticipated. With regard to the question as to how far under the lap the welding went, it was very difficult to express as an actual measurement, but it was not very far. The main point was to get homogeneity of the structure between the weld and the plate, although the depth of the weld was certainly an advantage. Wet weather had the same effect on welding as on riveting, and the only way was to do as much of the work as possible in the shops.

THE railway companies and the men's unions have come to a very wise decision with regard to the application of the English and Welsh companies to the Central Wages Board for a modification of wages and terms of service. Direct negotiations originally were proposed, but the unions intimated that they first wanted some outstanding questions, like the grading of signalmen, disposed of. In view of this objection the companies said they would go to the Central Wages Board. A change in the situation, however, occurred last week as the companies officially intimated that they were going to deal with the unions direct. The meetings as to grading of signalmen were also resumed.

A TOOTHLESS PINION.

A NEW form of gearing, known as the autopitch, was described in a paper by Mr. W. R. Darling recently read before a meeting of the Institution of Engineers and Shipbuilders in Scotland. In this gearing the wheel is formed with teeth more or less of standard pattern except that their height may be reduced by half. The pinion, on the other hand, is toothless or, perhaps more correctly expressed, has an infinite number of teeth. In its simplest form it consists of a doubly-flanged sleeve with a large number of hard steel wires of about 14 gauge arranged between the flanges parallel with the sleeve axis. The layer of wires is continuous right round the periphery of the sleeve and is retained in position by means of overlapping lips on the flanges. When the wheel is in engagement with the pinion each tooth of the former as it comes into the meshing position impresses its form in the semi-fluid layer of wires, there being just sufficient freedom among the wires to permit them to spread for the accommodation of the tooth. The transmission of power is apparently effected by a jambing action among the wires, which once the tooth form has been impressed on the layer prevents the wires from rotating on the surface of the sleeve. In more developed forms of the pinion, plungers, rollers, or other forms of cushion are arranged between the sleeve surface and the wire layer, presumably with the object of enabling the space between the flanges to be fully charged in the first instance with wires, and yet make it possible for them to spread to accommodate the meshing teeth of the wheel. The invention has been farther applied to bevel, worm, rack and sprocket chain drives. Among the many advantages claimed for this gear system is included the possibility of moving the pinion instantaneously or gradually into gear at any speed. It was stated that engagement had been effected at 2000 revolutions per minute without shock or danger of any kind. In the discussion on the paper some criticism was directed against the probable efficiency, first cost and wear resisting properties of the gearing.

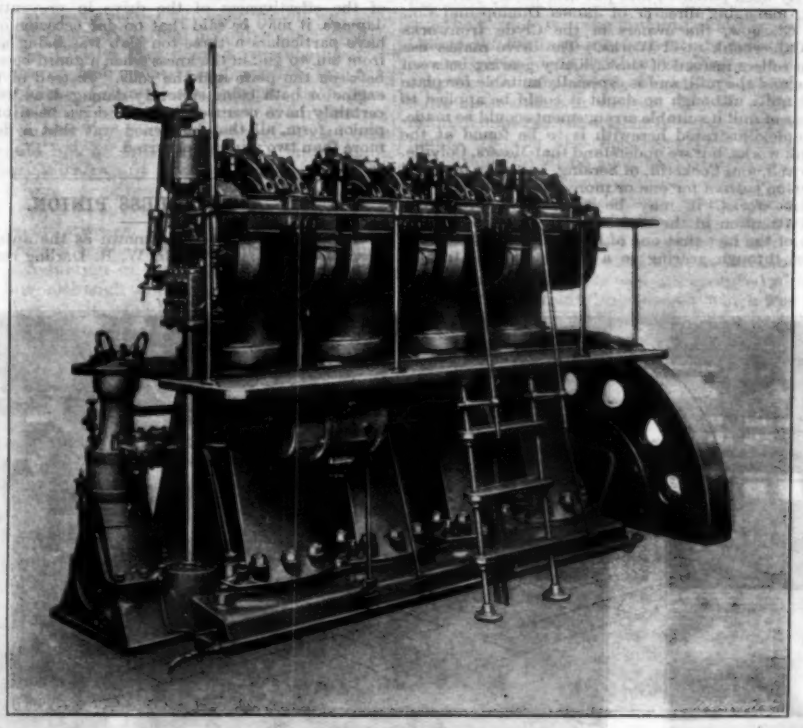


ROGERSON'S FRICTION ROLLER DRIVE APPLIED TO ROUGHING ROLLS

IN discussing Mr. Whitaker's recent paper on "Rotary Converters for Railway Work," Major A. M. Taylor is reported to have said that for the section of railway between, say, London and Birmingham, 1500 volts is nothing like a high enough pressure to employ, as, with the present traffic, the natural and proper spacing for the sub-stations would be 36 miles, and at that voltage no sub-station could economically feed a length of more than 6 miles, and even then there would be a transmission loss of 10 per cent. In other words, to deal with a total train-load of 6000 kilowatts, 36,000 kilowatts of sub-station plant would be required, of which, under the worst conditions, only 6000 kilowatts would be in active operation.

200-H.P. DIESEL ENGINE FOR PUMPING

MIRRLEES, BICKERTON AND DAY, LIMITED, HAZEL GROVE, ENGINEERS



Diesel-Driven Pumping Plant for Trinidad.

THE illustrations on page 242 represent a treble-ram pump recently built by Frank Pearn and Co., Limited, West Gorton, Manchester, for the municipality of Port of Spain, Trinidad. The pump rams, which are of cast iron, are 14¼in. diameter by 18in. stroke, and they work through gun-metal neck rings and cast iron glands. The pump has a capacity of 76,000 gals. per hour when running at 44 revolutions per minute, and the head is 350ft. The valves and seatings are of gun-metal and the pump valves and valve boxes are of cast iron, separate and interchangeable. The crank shaft is of forged steel and is carried in five gun-metal bearings which are adjustable. The connecting-rods are also of forged steel, and they are furnished with gun-metal adjustable bearings at both ends. The base-plate is made in halves and bolted together. The pump is driven through double helical reduction gearing by means of a 200 horse-power Diesel engine made by Mirrlees, Bickerton and Day, Limited, of Hazel Grove. The pinion shaft is carried in two adjustable gun-metal bearings fitted with ring lubrication, and the large gear wheel on the crank shaft, which is of cast iron, is made in halves, the joints being machined and the bolts fitted. The pinion runs in an oil-retaining gear case and the drive from the engine through the pinion shaft is transmitted by a friction clutch.

The engine, which is illustrated above, is of the four-cylinder, four-cycle pattern, giving 50 horse-power per cylinder when running at 250 revolutions per minute. There are three valves in each cylinder cover for the fuel, air inlet and exhaust respectively, whilst two of the four cylinders have an additional valve for admitting compressed air for starting purposes. In this type of engine, when the cylinders are fitted with starting valves, the fuel and starting valve levers are mounted on excentrics which can be rotated by a hand lever. When this lever is in the starting position the fuel valve lever is held clear of its cam, thus preventing the fuel valve admitting oil into the cylinder while the starting valve is in operation. As soon as the lever is moved into the "running" position, however, the starting valve is put out of action and the fuel valve commences to operate in the usual way.

A special feature of the Mirrlees engine is that all the valve levers are made in halves bolted together, so that by the removal of one bolt it is possible to swing back one half of the lever and thus permit the valve to be withdrawn from the cylinder cover without interfering with the remainder of the valve mechanism. This is an obviously convenient arrangement, and it results in a great saving of time. Another special feature of the valve gear is that a fuel by-pass valve is fitted between the fuel pump and fuel valve, so that in the event of the attendant neglecting to place the starting lever in the "running" position promptly no accumulation of oil can take place in the fuel valve casing. This device prevents the risk of excessive pressure in the cylinder which might be set up by the accumulation of oil. The water jackets in the cylinder covers, cylinders, &c., are provided with doors for cleaning purposes.

The pistons, which are of special design, have detachable tops, a construction which enables the upper portions to be made of metal of a high heat-resisting quality, while the piston body is made of harder metal to withstand wear. The fuel pump is actuated from an excentric on the cam shaft, a separate pump being fitted for each cylinder. The makers claim that this arrangement gives a more equal distribution of fuel to the various cylinders than is the case with a single pump for the whole of the cylinders. In the design of the governor special attention has been given to the elimination of friction by fitting ball bearings to the fulcrums of the governor arms and other moving parts.

The air compressor on the engine is of the two-stage type and direct driven from the engine crank shaft. It is of the vertical pattern with the high and low-pressure cylinders in tandem. Efficient coolers are provided to keep down the temperature of the air between the two stages of compression and also after the final stage. Both air cylinders are fitted with silent-acting disc valves. Air receivers of solid drawn steel are provided for air injection and starting, the receivers for the latter being in duplicate. All the valves throughout the engine have loose renewable seats, and spare sets of valves and seatings are provided to prevent the necessity of keeping the engine stationary should it be necessary to regrind any of the valves.

The lubricating system is arranged to enable the engine to run for long periods without stopping. Ring lubrication is provided for the main bearings, and oil chambers of large dimensions are cast in the engine bed-plate for this purpose. Oil pumps are fitted for supplying lubricating oil under pressure to the cylinders, pistons and connecting-rod top end bearings, while the bottom end of the connecting-rods are lubricated by means of centrifugal oiling rings. The makers inform us that the fuel consumption of these engines is only about 0.42 lb. per brake horse-power hour on test, and that better results have been obtained in actual service.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

RAIL CORRUGATION.

SIR,—Referring to the above much vexed question, and the report of the Committee on Rail Corrugation, as published in THE ENGINEER of January 20th, which apparently proves that the corrugations are not in any way connected with the stiffness of the rail itself, but that it is caused by excessive stresses set up in the rail head.

That it is produced by excessive stress should leave no doubt in the mind of the engineer, but if this were a general rule under any conditions, one would expect to find the whole of the track corrugated equally instead of in patches, and this is the point to which the attention of the permanent way engineer should be particularly directed.

Assuming that in a general way the rail head is worn away evenly and smoothly, which appears to be a fact, there must be some special conditions which are at work which cause corrugations to appear in patches, and from personal observations, taken on the railway and tram tracks, the following appear to be the places most affected :—(1) Those sections where there is an application of the brakes ; (2) locally on the facing ends of rail joints ; (3) occasionally on various other lengths.

Dealing with No. 1 first, it will be well to state at the outset that the application of the brakes is not the sole cause of rail corrugations, but that it produces, or tends to produce, the conditions which do cause it.

If it were the only cause we should expect to find corrugations set up at all such places, which is not the case, so that other factors are evidently at work.

In the author's opinion, and as borne out by his personal observations, the real cause is due to chattering set up between the axle-boxes and the hornblocks combined with the horizontal surface friction.

The chatter between the axle-boxes and hornblocks when the brakes are applied is caused by the axle-box striking the back slide, causing it to rebound on to the forward slide, and it would then remain at rest on the rail until again struck by the back slide.

This chatter action would produce all the necessary conditions for producing rail corrugation, and the probable interval would be about 2in. or 3in., which pitch would mean a periodic vibration of about 70 or 100 per second at about 20 miles per hour.

This axle vibration appears to be caused by three main causes, *i.e.*, (1) side play of axle-boxes ; (2) brake application ; (3) high centre of gravity relatively to length of wheel base.

Taking each of the above in order, if the side play were entirely eliminated, so also would be the rail corrugations.

Secondly, the application of the brake has a decided influence on the axle-boxes, and produces, or tends to produce, wheel chatter, which can easily be noticed, especially in old stock with loose and worn brake blocks, in railway passenger stock at certain times, and this is the probable reason why rail corrugation is most in evidence on stretches of line where brakes are mostly used.

From observations, rail corrugation is found in other places, but generally the original cause can be traced to a period of brake application, as the author has yet to see rail corrugation on a gentle rising gradient.

The third cause which might produce hammering on the rails is a high centre of gravity relatively to the length of wheel base, as, during the application of the brakes, or a strong tractive force, the higher the centre of gravity the more nearly would the resultant force act in a vertical direction, which would produce excessive loading on the leading wheels in the case of brake application, and excessive loading on the driving wheels in the case of starting.

If the above theory is the correct solution of the cause of rail corrugation, it remains to be seen if the places where corrugations occur tally with the above supposition, and in the author's opinion they agree very closely, as will be shown by the following observed localities :—

Brake Application.—L. and N.W. Railway : On the downward gradient through Edge-hill into Lime-street Station, and not on the rising roads. South Lanes. Tramways : On the hills near to Worsley Station and not on adjacent level stretches.

Low Centre of Gravity.—L. and Y. Railway : The author is not aware of any corrugations on the electrified line between Southport and Liverpool. This is comparatively new stock kept in good condition, with a low centre of gravity, and it will be interesting to notice if any corrugations occur as the rolling stock develops slackness in the axle-boxes ; but even in this case the low centre of gravity may more than balance this effect.

That corrugations should occur with more frequency on tramways than on railways is also accounted for by the above theory, as in the former case the rails are more or less covered with grit, &c., off the roadway, which would cause unequal friction and tend to set up axle chatter ; and, further, the rolling stock of the tramways receives more harsh treatment than the rolling stock of the railways, which would cause more wear between the axle-boxes and hornblocks of the trams than railway stock.

In conclusion, I might add that I shift the responsibility for rail corrugation off the shoulders of the civil engineer and place it on the mechanical engineer. I shall be pleased to hear from any engineers who have obtained any results on the above subject.

D. LEIGH, A.M. Inst. C.E., A.M. Inst. M.E.

Manchester, February 24th.

INTERNAL COMBUSTION TURBINE.

SIR,—The letters of Mr. Hepburn and Mr. Davey on the above subject, which have been appearing in your columns during the past few months, are of very great interest and value to students of this problem.

Mr. Hepburn's suggestion of using the residual kinetic energy in the gases after leaving the moving turbine blades, for self-compression in a high-speed kinetic compressor, constitutes a new line of attack upon the constant pressure single fluid cycle, and leads—as has been shown by Mr. Davey in his letter in your issue of February 17th—to an increase in overall efficiency of about 60 per cent. over the usual system in which a rotary compressor is employed. Such an appreciation from one whose name is so closely identified with the mixed fluid type of constant pressure turbine, is in itself of considerable value and is enhanced by Mr. Davey's standing as an authority on the subject and author of the foremost text-book in the English language on the gas turbine.

There is a twofold merit in Mr. Hepburn's proposal, and, moreover, his attack is directed to the vital points in the problem. He obtains a big improvement in the mechanical efficiency of the expansion part of the cycle by elimination of the residual kinetic energy loss, and uses this kinetic energy for self-compression of the gases, thereby obtaining a higher efficiency in the compression part of the cycle and materially reducing the size of the compressor. Mr. Stern, in his interesting report to the Aeronautical Research Committee—Engine Sub-committee Reports, No. 54, H.M. Stationery Office, price 2s.—brings out very clearly the importance of the efficiencies of both the expansion and compression parts of the cycle, and shows that a few per cent. gained or lost in either will be very much magnified in the overall efficiency value. By operating on Mr. Hepburn's system it is possible to obtain a relatively high mechanical efficiency of the whole cycle, and by working on a sub-atmospheric cycle a high absolute thermal efficiency can be obtained, so that the overall efficiency is likely to be higher than when operating on any other system.

The exceeding simplicity of the single fluid constant pressure cycle, in which, when using a kinetic compressor, the only moving parts will be the turbine wheels and the gas, make it very attractive indeed, and far more so than the constant volume cycle of Holzwarth—hitherto regarded as the dark horse of gas turbine cycles—in which it is necessary to close the combustion chambers by a specially operated valve while the explosion is taking place.

The natural objection which occurs to anyone who has not given much consideration to the matter is that the high velocities will lead to big frictional losses ; but a closer investigation shows that, contrary to what would be expected at first sight, these losses are not excessive. From my letter in your issue of February 10th it will be seen that the loss in a high-speed kinetic compressor working on a sub-atmospheric cycle will be less than 50 per cent. of the loss in an ordinary rotary compressor having the same compression ratio and working above the atmospheric line. Having regard to the low average density in the cooler, the same line of reasoning will show that here the frictional losses are also not excessive.

Mr. Hepburn, in displacing the rotary compressor, has evidently not overlooked the necessity of maintaining the vacuum by other means, and his expansion of high-pressure gas in a

nozzle system to attain this end will necessarily be a matter for experimental research, as also will be the possibility of maintaining a spinning mass of gas upon which the effectiveness of a kinetic compressor would seem to depend.

Mr. Davey has emphasised the point that the real competitor of the gas turbine is not the Diesel engine, but the steam turbine. I do not think that anyone who has seriously studied the subject can be under any misapprehension on this point, but it would be idle to disregard altogether the influence of the vast capital now mobilised in the construction of reciprocating internal combustion engines. This point was touched upon in the leading article in your issue of September 23rd last.

The steam turbine, after many years of experimental work, appears to have reached the limit of its development with an overall efficiency of about 25 to 26 per cent. Even with present-day materials the gas turbine should be able to realise and surpass this performance with substantial gains as regards weight and space. It should, moreover, be borne in mind that all the improvements that may be made by metallurgical research, whereby the limiting temperatures and peripheral velocities may be raised, will tend to improve the efficiency of the gas turbine.

Mr. Davey has suggested that the apathy shown in this country towards research on the gas turbine arises in part through giving the dog a bad name, and in view of the facts as regards the efficiency which should be obtained, it must be confessed that this seems to be the case. It is to be hoped that this state of affairs will not continue, or else this country, in addition to having to build the bulk of its Diesel engines under foreign licences, will suffer the further humiliation of importing foreign turbines, for in Germany the research work on the constant volume cycle is actively proceeding.

I hope Mr. Hepburn will be encouraged to pursue his investigations and will receive the necessary support and assistance from the big firms for carrying out experimental research work.

W. A. D. FORBES, R.C.N.C., A.M.I.N.A.

London, February 25th.

THE BUXTON BOILER EXPLOSION.

SIR,—In confirmation of the great pressure that is necessary to start a body from a seating in which it is held merely by wedge action it may be recalled that all the fittings on the well-known Stanley steam cars were merely spigot plug joints driven into taper holes in the shell, including the main steam pipe. I have carried 750 lb. in such boilers on occasion and never had the slightest trouble with such pressures. The diameter of the main steam pipe of the 10 horse-power model, from memory, would be about 1¼in.

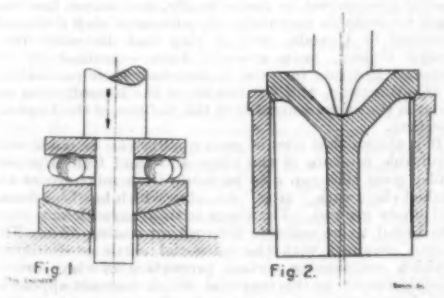
May not the steam car, too, in another form possibly provide data that explains this mysterious explosion? I allude to the bare possibility of low water permitting the fire-box crown to become partly dry; say, if the engine were not standing quite level, for instance, and assuming that the lead plug had failed or was even still submerged. The evidence would not be against such explanation, as we are told that the boiler went up after the engine had made some four beats. Assuming that she was moved off, after a twenty minutes' wait, in a forward direction, the inertia of the water would cause it to pile up over the fire-box crown, and a flash of steam into an already over-pressed boiler might account for a sudden pressure that the abandonment of the spheroidal state theory would otherwise make it difficult to explain. The absence of signs of overheating are against this, it is true; but such overheating would not be excessive in the short time—twenty minutes—that the engine was stationary if, as it is assumed, the fire-door would be open and the fire dull. Also to detect signs of overheating from the shattered *débris* might be difficult. But for this point in the evidence, the conditions that might be imagined, and the fact that the boiler burst *after* the maximum pressure had been reduced by opening the regulator, would rather lend colour to such a theory in the absence of any more satisfactory than those at present put forward.

S. P. C.

Bawtry, February 25th.

SIR,—On reading the report in the current number of THE ENGINEER of the inquiry into the cause of the Buxton boiler explosion, and on examining the sectional drawing of the safety valve, a cause of the safety valve sticking occurs to me that may not have been fully considered.

I should like to mention at the outset a difficulty that occurred some years ago with ball thrust bearings having so-called spherical seats, which are frequently tapered seats and not truly spherical. The object of these spherical or tapered seats is to enable the bearings to align themselves so that all the balls take the same amount of thrust; but in practice I discovered that no amount of end pressure, *i.e.*, axial pressure, would cause the



bearings to align themselves if put together out of line, friction between the surfaces preventing movement under load. Sketch No. 1 illustrates my point, but is exaggerated for the sake of clearness.

In the case of the safety valve, the conical seat of the valve is not unlike the so-called spherical seat of the ball thrust bearing, and although I have not a safety valve with which to experiment, I have little doubt that the valves could be tilted slightly one way or the other, and that no amount of pressure from the spring would bring them central again. The effect would be that one, or perhaps two, of the wings of the valve might press with great force against the inside of the bush, the pressure being so great as to prevent the valve moving under even excessive steam pressure. The fact that the wings project below the bush would positively prevent the valve rising. Sketch No. 2, also exaggerated, shows this.

The analogy between this valve and the ball bearing seems to me sufficiently great to render the matter worthy of inquiry.

P. V. VERNON.

Coventry, February 23rd.

SIR,—By combining my suggestion and your comment on it, I think we can almost certainly say how the accident was caused. Failing this, I can at all events show that the design involves considerable danger. If, as you say, the bulge to which I drew attention is a strengthening ring, it forms part of a circle, being thickest on the centre line of the engine, and going away to nothing on each side.

What is likely to happen? A man goes to insert the valve; one of the wings is fairly sure to foul the bulge. He turns the valve until it will just enter. It is then within a hair's breadth, one might say, of being jammed. The jam may come about either by differential expansion—which is by no means unlikely, considering the difference of material, and the fact that the column is only protected from the outside air by a thin casing—or by the valve turning round very slightly. It is not difficult to see how a minute turn could come about. The depression in the top may not quite suit the point on the lever, being a trifle excentric or otherwise, owing to the valve being in a different position to that which it occupied when in the engine before. In that case it is quite possible that the steam pressure might screw it round a little, and wedge it.

I agree with you, Sir, that the lever should enter the cab, and think that if it had done so this disaster would probably never have occurred. And I further consider that there should be no projections whatever in the passage anywhere near the level of the bottom of the valve at its lowest position after repeated grinding in. The valve ought to be free to turn round and round without coming into contact with anything but its seat.

C. F. DENDY MARSHALL.

Guildford, February 26th.

[The valves were ground in by hand in the usual way. In that process they are gradually turned round and round, and it is hardly conceivable that the mechanic could miss the touch of a projection on the wings.—ED. THE E.]

SIR,—One theory respecting the cause of this disaster is that the safety valves had unknowingly been adjusted to blow off at a very much higher pressure than the registered pressure of the boiler. In the ordinary way, this higher pressure would be reached now and again, when the valves would blow off. The steam gauge would read high, but the safety valves would appear to have nothing the matter with them. The boiler would be able to withstand the excess pressure for some time, but would become gradually weakened. The weakening process would go on until a pressure, still greater than the registered pressure, yet one below the point at which the safety valves would lift, would become sufficient to bring down the roof of the fire-box.

The accuracy of this theory cannot be now established, but neither can the theory that the safety valves stuck, seeing that they were known to have acted from time to time prior to the day of the explosion. Again, the late Mr. Webb's particular arrangement of valves of the Ramsbottom type—presumably still in use—seems to preclude the possibility of the valves becoming suddenly inoperative. Still, as you state in your leading article, their sticking, unaccountable though it be, may be the most acceptable of all explanations, as the steam test ought to have disclosed any inaccuracy in the first instance.

F. W. BREWER.

Stevenage, Herts., February 27th.

[The evidence of drivers is to the effect that on several occasions the valves blew at 180 lb. and at 200 lb.—ED. THE E.]

BLAST-FURNACE AS GAS PRODUCER.

SIR,—I read with interest Mr. Jones' letter in your issue of the 24th instant, with regard to power economy. No doubt it will interest your readers to learn that during the late coal strike one of the blast-furnaces belonging to the Midland Coal, Coke and Iron Company, Limited, Apedale, Staffordshire, was used as a producer during the whole of the time that the strike lasted, and supplied with gas the gas engine for blowing the furnace, and also the gas engine-driven alternator set. The power from the latter was mainly used for pumping purposes at their many collieries.

Whilst the furnace's main duty was to supply gas, it was also making about 30 tons of pig iron every twenty-four hours, and, I believe, was the only furnace in Great Britain which was in operation through the strike.

WILLIAM STEAD.

Manchester, February 27th.

HOT AIR FOR COMBUSTION.

SIR,—In reference to my letter on the above subject, published in your last issue, and Mr. Utting's reply, my statements on further perusal certainly do appear somewhat unfair, but the rather sweeping comparison which provoked a reply of this nature will, I hope, be taken into consideration.

With regard to the exit gas temperatures, given equal weights of air per pound of coal and equal combustion, the outlet gas temperature is bound to be higher under the hot air system, because however more efficient the fore part of the boiler may be, there must be a stage between the inlet and outlet of the gases where the temperature in the hot air system is equal to the initial temperature in the cold air system, and the remainder of the boiler heating surface beyond this stage could not under these conditions extract a greater number of British thermal units than would be extracted by the whole of the heating surface of the boiler when supplied with cold air.

No doubt Mr. Utting has in his mind a less weight of hot air per pound of coal, *i.e.*, probably an equal volume, and it is, of course, quite likely that a greater percentage of CO_2 would be obtained and the total number of British thermal units to be extracted by the boiler would be correspondingly less, and under these circumstances one could understand that the exit gas temperature might be less, but unless the weight of air supplied to the furnace is ample, there might be a danger of overheating and incomplete combustion, owing to the fact that the high temperature would result in dirty fires, and one really comes back to the fact that given two up-to-date plants, the weight of air passed into the boiler will be practically the same for the hot air system as for the cold air system.

I have in mind a test carried out by myself with the greatest possible care, in order to compare a Lancashire boiler working with four steam jets, as compared with forced draught supplying air to the furnaces at a temperature of 158 deg. Fah., and the temperature of the gases leaving the boiler was 672 deg. Fah., as compared with a temperature of 688 deg. Fah. when supplying hot air to the furnaces. The water evaporated in the boiler per pound of dry fuel was 9.22 lb. when using steam jets, as compared with 8.56 lb. when using hot air, but from this 9.22 lb. of water per pound of coal must, of course, be deducted the weight of steam used by the forced steam jets, which in this case amounted to approximately 0.6 lb. of steam per pound of coal, and therefore the net amount of useful steam generated works out at 8.62 lb. per pound of dry fuel with steam jets, as against 8.56 lb. when using hot air.

At the time of this test, the extra efficiency was attributed to the fact that the steam jets broke up the fire, and better combustion was obtained.

As a matter of fact, the decrease in the weight of gases per pound of coal when using hot air amounted to approximately 1 lb. per pound of coal, but this reduction in gas volume was evidently not sufficient to reduce the outlet gas temperature to below the 688 deg. Fah. mentioned above, but probably, if the volume of air supplied to the furnaces had been considerably less, *i.e.*, very much more than necessary when using steam jets and just the bare amount when using hot air, there might possibly have been a decrease in temperature instead of an increase.

I trust that these figures will explain my own statement to the effect that under otherwise equal conditions, *i.e.*, same weight of air and same percentage of CO_2, &c., a boiler will discharge gases at a higher temperature when supplied with hot air than when supplied with cold.

GEORGE E. TANSLEY.

February 28th.

ANGLE COMPOUND AIR COMPRESSOR AT A COLLIERY.

SIR,—With reference to the letter signed "Civis" in your February 17th issue, we would say that your correspondent, we fear, is apparently confusing the question of turning moment with the question of balance of reciprocating forces. We are inclined to think he has rather missed the essential reason for the angular construction, which was clearly described in your article on this machine on January 27th.

We did not give the "delivery efficiency" of this machine in your columns, because, as you will recall, the client has run no test, and you very properly, we believe, follow the sound practice of not giving in your columns data from manufacturers' tests. Your correspondent might be interested to know that these compressors are a standardised product, each one of which is tested at full and partial loads in our works, where indicator cards are taken and filed for future reference, and to be assured that each machine is working in accordance with the standard laid down. We test these compressors for efficiency when there is any change in the design which affects their efficiency. We are quite prepared and very glad to give guarantees of volumetric efficiency, or, as we believe it is better termed, "delivery efficiency," determined by actual measurement of air delivered. We do not believe calculated volumetric efficiency based upon indicator cars is reliable.

SULLIVAN MACHINERY COMPANY,
AUSTIN Y. HOY, Manager.

London, February 24th.

ROYAL METAL TRADES PENSION SOCIETY.

SIR,—As chairman of the sixty-first annual dance in aid of the funds of the Royal Metal Trades Pension Society, held at the Hotel Cecil on February 24th, may I ask the favour of space in your columns to thank all who contributed to the success attained, and say how I appreciate their help?

Having been brought into intimate relation with the Society during my term of office, I have realised by first-hand knowledge the good that is done and the urgent need of such an institution.

I am surprised at the large proportion of the trade which does not subscribe. Something like 75 per cent. of the firms in the iron, steel, metal and hardware industries do not support their trade charity. I feel sure there is not one of the 15,000 firms whose aid has hitherto been withheld who would not gladly give a guinea or two a year, and by example induce many of their employees to contribute also, if they realised what the pension and the temporary grants mean to those who in their need turn to the Society for help.

It is my confident hope that the appeal I have made to every branch of the trade will bring a large access of permanent subscribers.

EDWARD LE BAS.

London, February 27th.

ENGINEERING GOLFING SOCIETY.—The Engineering Golfing Society held its thirteenth annual general meeting on Thursday, February 23rd, at the Institution of Civil Engineers, by permission of the Council of the Institution, the retiring captain, Mr. E. W. Timmis, presiding. The annual report and accounts for 1921, which were presented, showed a satisfactory increase in membership and a favourable financial position. The following were elected as office-bearers for 1922:—President, Sir Alexander B. W. Kennedy; Vice-presidents, Messrs. D. A. Stevenson, E. L. Mansergh, F. J. Walker, S. Price-Williams, G. Midgley Taylor, and W. H. Shortt; captain, Mr. K. A. Wolfe Barry; honorary secretary, Mr. W. L. Mansergh, 5, Victoria-street, S.W. 1; honorary treasurer, Mr. S. R. Lowcock, 6, Queen Anne's-gate, S.W. 1; honorary auditor, Mr. S. C. Lewis; members of Committee: Messrs. H. G. Hale, B. J. Hall, C. H. Hayward, R. J. M. Inglis, E. C. MacKellar, J. R. Sharman, G. M. C. Taylor, E. W. Timmis, and A. Valon.

A LARGE CASTING.—The Brightside Foundry and Engineering Company, Limited, Wicker Iron and Engineering Works, Sheffield, has sent us photographs of a remarkable casting in the form of an ingot mould which is said to be the largest ever made in this country. The weight is approximately 110 tons. The inside dimensions are 108in. by 68in. by 148in. long, and the thickness of metal varies from 15in. to 18in. in the body to 24in. in the belts. The mould was built in a 16ft. pit, and the centre core lowered in. For casting it took one 45-ton ladle one 23-ton, two 17-ton, one 8-ton and one 7-ton ladles. The melting time was about seven hours, and the casting was poured in 4½ minutes. The casting was fed for six hours and took three weeks to cool. It had to be delivered by road, but no difficulty was experienced. The 150-ton crane at the Newhall-road works of the Brightside Foundry and Engineering Company, Limited, picked the casting up and deposited it on the truck, while six traction engines drew it to its destination.

A Position Line Slide Rule.

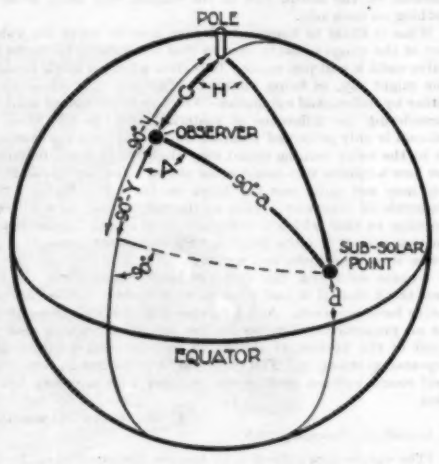
It is surprising that while the engineer has a slide rule for nearly every calculation that he has to make, and while special rules have been devised for the use of the electrician, chemist and optician, the navigator, who has to go through exactly the same computation every time he takes a sextant observation, still employs logarithmic or other tables. The main difficulty in designing a slide rule for reducing sextant observations lies in the great accuracy that is required. To be of any use at sea, the calculation must be correct to 1 min. of arc, and as a range of as much as 90 deg. is involved, the accuracy required is 1 part in 5400. This fact necessitates a very long scale and has led to the helical form being adopted for the scales of the slide rule illustrated herewith, which has recently been developed for the purpose. This rule was designed in the first place for use in the air, where the accuracy required is not so great as at sea; but as it has proved to

FIG. 1

be capable of giving a result correct to 1 min. of arc, it should be of great use to the sea navigator. Before describing the slide rule, the problem to be solved may be briefly outlined for the benefit of those who are not familiar with the principles of nautical astronomy.

If the North Star were exactly over the North Pole, then if this star were observed with a sextant to be 90 deg. above the horizon, that is, exactly overhead, the observer would be at the North Pole. If the star were observed to be on the horizon, then the observer would be at the equator. If the star were observed to be 45 deg. above the horizon, the observer would be somewhere on a circle midway between the Pole and the Equator, that is, at 45 deg. latitude. With the North Star so situated the observed altitude would thus always be equal to the latitude of the observer. The heavenly bodies commonly observed are, however, never exactly over the Pole, and are indeed usually at a substantial angle from it. Nevertheless, the point on the earth under the heavenly body at any instant of time is known from the data given in the nautical almanac. This point is called the subsolar or substellar point, referring to the sun or star respectively. If this point be regarded as a "Pole" and circles of "latitude" imagined round it, then an observation of the altitude of the heavenly body would tell the observer on which circle of "latitude" he is situated, and this circle would be known as his "position circle." At night, when two stars can be observed simultaneously, he would locate his situation on two such position circles, and a definite "fix" would be obtained as indicated in Fig. 1. If one star, having its substellar point at A, were observed to be at 50 deg. altitude, the observer would know that he was somewhere on the full line circle. An observation of a second star, having its substellar point at B, and about 55 deg. altitude, would give the dotted position circle, so that the observer's position would be fixed at P^1 or P^2. If the stars were suitably chosen P^1 and P^2 would be widely separated, and there would be no doubt as to which was the correct position.

The approximate position of the observer is always known and is called the dead reckoning, or D.R. position. The problem is simply to transfer the small part of the position circle near the D.R. position, with which the navigator is concerned, to the chart. As the circle is always very large, a small portion may be regarded as a straight line, and is known as the "position line." The problem can most easily be solved, as shown in Fig. 2, by starting from the D.R. position at which the observer imagines himself to be, and calculating, for this point, the altitude and azimuth of the observed heavenly body at the time of the observation. Then if the observed altitude is less than the calculated altitude, the position line is farther



H = HOUR ANGLE. C = CO-LATITUDE.
A = AZIMUTH. d = DECLINATION.
l = LATITUDE. a = ALTITUDE.

DOTTED LINE — PERPENDICULAR FROM SUB-SOLAR POINT TO OBSERVER'S MERIDIAN.

1. $\tan y = \frac{\tan d}{\cos H}$

1a. $\begin{cases} d \text{ AND } l \text{ SAME NAME}, Y = C + y. \\ d \text{ AND } l \text{ OPPOSITE NAME}, Y = C - y \end{cases}$

2. $\tan A = \frac{\tan H \cos y}{\cos Y}$

3. $\tan a = \cos A . \tan Y$

"THE ENGINEER" SWAIN SC

FIG. 3

than the D.R. position from the subsolar (or substellar) point, by as many nautical miles as there are minutes of arc difference between the altitudes. This difference is called the intercept. If the observed altitude is the greater, then the position line is nearer the subsolar point. If two heavenly bodies could be observed, two position lines could be obtained, and the observer's position definitely fixed at their intersection.

The problem thus resolves itself simply into calculating the altitude and azimuth of any heavenly body that would be observed from a D.R. position at a certain time. The latitude of the D.R. position is known, the declination of the observed body is given in the nautical almanac, and the hour-angle can be found from the solar time and the longitude of the D.R. position in the case of the sun. In the case of a star, the hour-angle is found from the sidereal time, right ascension and the longitude. Computing the altitude and azimuth from this data is a problem in spherical trigonometry, and there are several formulæ that can be employed. Navigators usually use the "haversine" formula, but this formula is not very suitable for use on a slide rule, as several scales would be required, and the azimuth would have to be found by a separate operation. The construction and formulæ shown in Fig. 3 have therefore been utilised.

The rule itself is shown in Fig. 4. It is 9in. high and 2½in. in diameter, and weighs less than 2 lb. complete with its case. Two scales are printed on two cylinders sliding with reference to each other. The inner cylinder, on which all results are read, is graduated with log tangents, and the spiral scale is about 24ft. long. It is divided into minutes of arc throughout its length, and the smallest degree division, occurring at the middle of the scale, is over an inch in length. The outer scale is graduated with log cosines. Two pointers, one for each scale, are attached to a sliding ring, a stop being provided to register the cosine pointer on the zero of its scale. As can be seen from the formulæ, given in Fig. 3, the calculation is performed on the rule in three stages. The first operation gives "y," which is added to, or subtracted from, the co-latitude, the second operation gives the azimuth, and the third the altitude. The pointer which has to be used for each setting is clearly marked, and full instructions for dealing with all possible cases are printed at the bottom of the outer cylinder. Simple rules are also given for dealing with hour-angles and azimuths above 90 deg., the scales being graduated backwards from 90 deg. to 180 deg. for this purpose. After a little practice, the calculation can be performed in less than two minutes, and the result should never be more than 1 min. of arc in error. A complete check calculation can be made if desired, by repeating the calculation with the declination and the latitude interchanged, when the same altitude should be obtained.

This slide rule was designed at the Air Ministry Laboratory, South Kensington, by Captain L. C. Bygrave, and

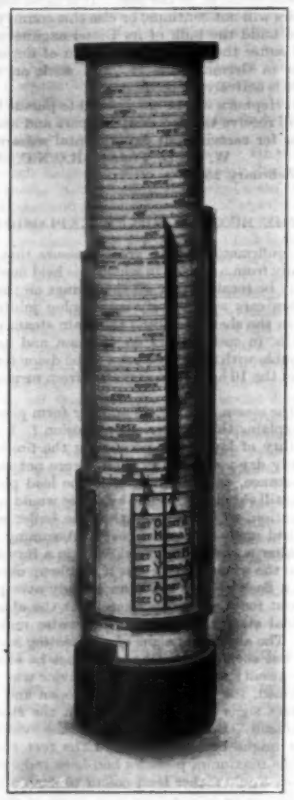


FIG. 4

has been patented by him. It has recently been placed on the market by Messrs. Henry Hughes and Son, the well-known nautical instrument makers.

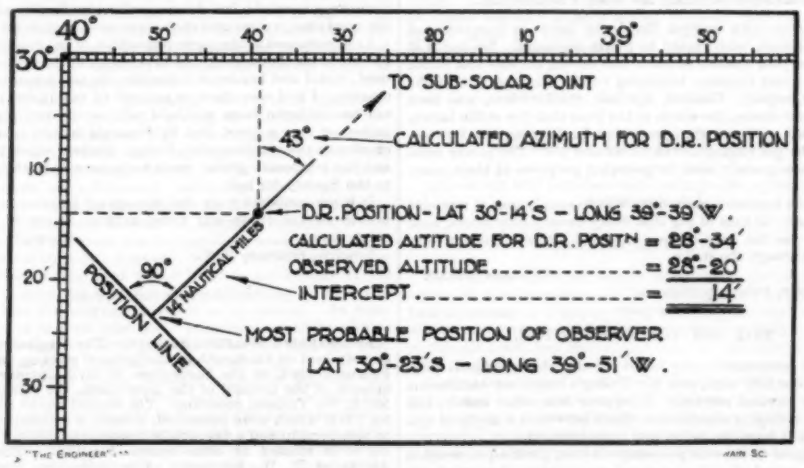


FIG. 2

ROOFING TILES IN EAST AFRICA.

The provision of roofing material for buildings in the tropics is often a matter of difficulty. Corrugated iron is largely employed, but it is frequently very costly, and, moreover, tends to make the building unbearably hot. In several countries in Africa it has been suggested that roofing tiles should be made locally, and search has been made for suitable materials. Specimens of clay and sand, collected in Uganda, and of clay and diatomite from Kenya Colony, have recently been examined at the Imperial Institute in order to ascertain their possibilities in this direction, and the results of the investigation are given in the current number of the *Bulletin* of the Imperial Institute.

It is shown that tiles of good quality can be made with a suitable mixture of the clays and sand from Uganda, whilst good tiles can also be made from mixtures of the washed clays with "grog," *i.e.*, clay which has been burnt and finely ground. The clays from Kenya Colony were also found to be suitable for making roofing tiles. The results obtained with the infusorial earth or diatomite —which contained a certain proportion of clay—are of special interest, as this material, which does not appear to have been employed previously for the purpose, furnished tiles which were much lighter than ordinary roofing tiles, which is a great advantage. There are extensive deposits of infusorial earth in Kenya, not at present worked.

Liege Engineering College. — The Association des Ingénieurs Sortis de l'Ecole de Liége is proposing to hold in June and July next a scientific conference and technical exhibition to commemorate the seventy-fifth anniversary of its foundation. The conference will last from June 11th to 16th inclusive, but the exhibition will remain open till July 14th. Further particulars may be obtained by application to Monsieur O. Lepersonne, Association des Ingénieurs, 16, Quai des Etats-Unis 16, Liége, Belgium.

Timothy Hackworth and the Locomotive.

By ROBERT YOUNG.[1]

FOR the present purpose, which is to put before you as full an account of the locomotive achievements and personality of Timothy Hackworth as the time at my disposal permits, I propose beginning with the year 1824. In that year Stephenson's various activities had assumed important dimensions. In addition to the engine works, he was constructing the Stockton and Darlington Railway, and had also been appointed surveyor of the Liverpool and Manchester Railway, where his presence for some months became imperative. He applied to Hackworth, who agreed to go to manage the locomotive works at Newcastle, purely as a temporary measure—as a borrowed man—during the few months of Stephenson's necessary visit to Liverpool,[2] and at Newcastle part of Hackworth's work was in connection with the building of the first locomotive for the Stockton and Darlington Railway, constructed from George Stephenson's matured designs.

Hackworth remained at the Forth-street works during the agreed period, carrying out his work efficiently, but not materially altering the locomotives under construction. He did, however, suggest dispensing with the chain coupling which had long been a feature of the Stephenson engines, and in place of it fitted side rods on the wheels, the first ever used on a locomotive.[3] When Stephenson returned he was very desirous that Hackworth should join him in the business, going to the length of offering him one-half of his own interest, a proposal which was declined.[4]

Stephenson, unable to secure Hackworth in his own firm, was well aware that he might prove a serious business rival in Newcastle, and strongly urged his being appointed engineer to the Stockport and Darlington Railway, a position which had previously been suggested to Hackworth, which, when definitely made, he accepted. He entered on his duties in June, 1825, and for the next fifteen years, through the most critical period to one of great success, maintained his connection with the Stockton and Darlington Railway.

There is a popular conception that the early days of this railway were marked by successful operation, and that the locomotive at once solved all difficulties of transport and entered on an uninterrupted course of triumph. The exact opposite was the case. The first two years were a period of anxiety, disappointment, almost of despair. The locomotives failed the company. There is no desire on my part to depreciate them. They were of the latest approved type. Hackworth himself had assisted in their design and construction, and his fortunes were closely bound up in their success. But the facts are clear, and the results of their working produced a state of affairs approaching panic. The late Joseph Tomlinson in his presidential address to the Institution of Mechanical Engineers in 1890 said: "When first Locomotion was put to work it would not make steam, and the fire tube had to be taken out and replaced by a return tube."[5] In his "Outline History of the Locomotive Engine," the late Theodore West tells us that in awkward and slippery weather the speed would flag rapidly, and driver and fireman would prise the engine wheels with crowbars till weary, when they would stop, fire up, and then sit down on the bank for a quiet pipe till steam had again risen.[6] An old workman who helped to light up Locomotion for its first trip said, "Eight waggons was as many as she could trail."[7] In THE ENGINEER, John Hackworth wrote that with sixteen chaldron wagons these engines required fourteen and often fifteen hours to run from New Shildon to Stockton—20 miles and back.[8] These circumstances were, of course, known to the Railway Committee, though discreetly omitted from the reports to the shareholders. Edward Pease wrote to Robert Stephenson in April, 1826, after the third locomotive, Black Diamond, had been delivered to the railway, saying that the business in Newcastle had suffered very much from his absence, and that unless he soon return it will be given up as "What is done is not done with credit to the house."[9] In 1827 Robert Stephenson received a similar letter from Thomas Richardson.[10]

The situation was not a cheerful one. The capital was all spent. The loans and debts owing amounted to more than £100,000. Some of the branch lines forming part of the original scheme were not even begun, and there was a shortage of money to pay current expenses.[11] Some of those who had advanced money were demanding it back, and an attempt to raise a new loan failed. During the ensuing months additional horses were employed on the line, and there was every prospect that the much-vaunted "travelling engine," uncertain, irregular, and constantly under overhaul, would make a final departure. "Owing to the inefficient condition of the locomotive power," says the *Practical Mechanics' Journal*, "the company had all but determined to abandon steam in favour of horses, when Mr. Hackworth proposed to construct an engine suitable for working the traffic.[12] The offer was accepted, and thus the Royal George came into existence. As a necessary economy, the boiler of a locomotive, built by Robert Wilson, of Newcastle, was taken for the new engine, lengthened and enlarged in diameter. The single straight flue was replaced by a malleable iron return flue, and this was the first boiler on the Stockton and Darlington Railway in which a return flue was fitted as part of the original structure, the former engines being all delivered with the straight flue boiler to which Stephenson adhered for so many years.

The boiler as rebuilt was 13ft. long by 4ft. 4in. diameter. The internal horseshoe flue was 26in. diameter at the furnace end, 18in. at the chimney end, and the heating surface was thus increased from some 60 square feet to 141 square feet. The cylinders were 11in. diameter, stroke 20in. They were placed vertically at the back of the engine working downwards and directly to cranks on the trailing pair of wheels, the pistons being guided by parallel motion, working a valve shaft on which were two loose excentrics. The wheels were Hackworth's "plug" wheels, 4ft. diameter, and four of the wheels were spring-mounted, being the first instance of a locomotive being carried on bearing springs. The springs were longitudinal, hinged on the main frame and acted also as balance beams. The Royal George had also a malleable iron cistern in which the feed water was heated by a portion of the exhaust steam, while another portion could be used if required as a jet under the grate to aid combustion. These were operated by a cock at the will of the driver. But the most important feature was the arrangement of the exhaust pipe as a perfect blast. Hitherto the Stockton and Darlington engines had been provided with two exhaust pipes, one from each cylinder, which were carried through the chimney and discharged the waste steam upwards just inside the chimney.[13] Hackworth brought his single pipe direct into the centre of the chimney, where it was bent upwards with a coned malleable nozzle, through which the steam was ejected with greatly increased force, forming a powerful blast, perfect in its application and enabling boiler pressure to be maintained under all conditions.

The engine was tried in September, 1827, began running regular traffic in November of the same year, and immediately proved its capabilities. In an old memorandum book of Timothy Hackworth's, I find the following notes: "William Golding Royal George engine on the evening of 13 Dec. 1827 coming up the line with 20 waggons the ring round the fire tube gave way two feet in length, he put the waggons into the siding. This engine was put on the line a fortnight before, made a journey each day, one journey to Darlington with 24 waggons and can gender steam to propel the waggons well. Set off with the first journey to Stockton with the said engine Nov. 29, 1827, performed the journey well." This unfortunate accident laid the engine up for five weeks, but under date January 22nd, 1828, is the further note: "Royal George Locomotive made two Darlington journeys, Golding engine tender." Its career was then one of great success, and it may reasonably be said that on the results of its working the future of the locomotive system depended so far as the Stockton and Darlington Railway was concerned, and that its failure would seriously, if not fatally, have affected the introduction of steam locomotives elsewhere. During 1828 it conveyed 22,422 tons of coal over 20 miles at a rate of a farthing a ton per mile. The cost of this, including repairs, maintenance and interest on capital, was £466, where, according to the *Practical Mechanics' Journal*, horses for the same work cost £998.[14]

The success of the Royal George must be considered in relation to the work demanded of it, and for which it was designed, namely the coal traffic. Speed on the single railway, with its mixed traffic, was neither desirable nor practicable. The Committee discouraged it and severely punished offenders. While the new engine could travel 11 miles per hour with its load, speed was at this period limited to 5 miles. Its regular train load was twenty-four wagons, each with a deadweight of 1 ton 4 cwt., and each carrying from 53 cwt. to 3 tons of coal,[15] nearly 100 tons gross without tenders. Several small circumstances confirm the evidence of efficiency of the engine, which are not devoid of interest. The Committee—always rigidly economical and far more prone to inflict fines than bestow rewards—actually voted the sum of £20 to Hackworth as a bonus for building the Royal George.[16] The driver, William Gowland, earned considerably more wages than any of the others,[17] the pay being on tonnage rate and, therefore, an accurate gauge of work done. Timothy Hackworth's memorandum book for part of 1828 gives the wages earned by the five drivers in March of that year, which form a very good testimonial to the new engine. The list is as under:—James Stephenson received £18 5s. 4d.; Robert Morrow received £18 9s. 4d.; William Gowland received £37 18s. 11d.; Michael Law received £22 18s. 1d.; John Cree received £22 5s. 5d.

It can scarcely be considered surprising that, as Gowland wrote in THE ENGINEER, he was "an envied man,"[18] and that Morrow, to whom the Royal George had first been offered, regretted his refusal.

After the Royal George had been running for a year, the Committee passed the following resolution: "From an accurate observation of the locomotive with six wheels and springs, the Committee have every reason to be satisfied the same is a great improvement. It is resolved that T. H. be directed to attend to having similar improvement made in all our engines as early as possible."[19] So far as financial results followed the introduction of the new engine, the balance sheet of the company for the year ending June 30th, 1828, when the Royal George had been running seven months only, shows the coals conveyed had increased by 50 per cent. and the receipts were up £5000, the ratio of working expenses being reduced from 64 per cent. to 52 per cent.[20]

It must be borne in mind that the directors of the Liverpool and Manchester Railway appointed a deputation to report as to the feasibility of stationary or travelling engines for their railway, and this report was published in March, 1829, recommending the use of stationary engines. Robert Stephenson thereupon led a powerful opposition to it, in which he enlisted Hackworth's assistance, and it is a very significant fact that, to enforce his arguments, he produced the Royal George, and the work done by that engine. Not one of his own locomotives, not the Experiment at Shildon, not the Lancashire Witch at Bolton, nor the Twin Sisters at Liverpool, but Hackworth's engine. Of this engine the report said:—

"Hackworth's engine is undoubtedly the most powerful that has yet been made, as the amount of tons conveyed by it, compared with other engines, proves. Its consumption of coal per ton of goods conveyed one mile, at the rate of 11 miles per hour, was 1.60 lb; Blenkinsop's engine, at 4 miles per hour, 2.75 lb.; Killingworth and Hetton engines, at 4 miles per hour, 2.25 lb."[21]

I have dealt at some length on the Royal George, because it marked a new era in locomotive building and definitely asserted the superiority of steam over horse traction. So long as the railway subordinated speed to power, or were content without the combination of speed and power, this type of locomotive was worked with great success and economy. It was cheap to build, to run and to maintain. It was simple, strong and durable, and the type held its own for many years. Similar engines were introduced on other coal railways and some were still at work in 1882.

It seems to me that for his work alone in producing this engine—at a specially critical period in locomotive history—Hackworth's name deserves to be included in the front rank of the great locomotive pioneers.

The next engine built by Hackworth was the Victory, in 1829, on similar lines to the Royal George, but the pistons were guided by circular slide bars instead of parallel motion, and the cylinders were 12in. diameter with a stroke of 22in.

In April, 1829, the directors of the Liverpool and Manchester Railway decided to have a locomotive competition which was fixed for October of the same year. Hackworth resolved to compete and built a small engine which he called the Sanspareil, similar in design to the Royal George, but on four wheels only. This competition has passed into history. It was won by Robert Stephenson's Rocket, but for the first two hours the Sanspareil ran with great regularity, covering over 25 miles, and as a report of the contest says, "It was soon manifest that a very powerful competitor had entered the field."[22] The cause of failure was the bursting of the partition between the bore of one cylinder and the port-way along the cylinder side,[23] which happened soon after the start, the fracture opening at every stroke a direct communication from the steam pipe to the chimney. This not only caused great loss of steam, but also the ejection of fuel at each opening of the slide valve, and rendered the Sanspareil's chance hopeless. The cylinder was replaced immediately after the contest, the engine was purchased by the directors, was sent to the Bolton and Leigh Railway, where it ran for many years, and now has its resting place in the Science Museum, South Kensington.

Nicholas Wood's chronicle of the contest—the universally accepted authority—did much injustice to Hackworth. He assigned the fuel ejection to a too powerful blast, and gave the fuel consumption—which was of course excessive—without reference to the unfortunate cause of it.[24] It is only fair to state that the whole work of the Sanspareil could not be carried out in the small repair shop at New Shildon. The boiler was made at Bedlington, and the cylinders—the cause of all the trouble—were cast and finished at the factory of Robert Stephenson and Co., Newcastle.

Immediately after his return to Shildon, Hackworth was instructed to design an engine for passenger traffic for the extension of the railway from Stockton to Middlesbrough. This engine marked a new departure. Speed, reliability and steadiness in running were required. The engine was designed in 1829, approved early in 1830, and the plans were sent to Robert Stephenson and Co., by whom the engine was built. Among the novel features were a copper circular steam dome, four coupled wheels, 5ft. diameter, the largest yet made, inside horizontal cylinders with crank axle, and valve motion reversible by a single lever. The cylinders were 9in. diameter by 16in. stroke, placed under the trailing end of the engine. The boiler was also on new lines, a single flue 9ft. 3in. long with radiating small tubes passed transversely through the main flue, and through these water circulated. Ordered at the beginning of March, 1830, it was not finished till December, when it was used to open the new line to Middlesbrough, and known as the Globe, continued in successful use for nine years, when it came to an untimely end through the explosion of the boiler.

In 1833 Hackworth entered into an agreement with the railway company by which he took over the rolling stock at a valuation, found all material and workmen, and contracted for the whole traffic for a payment of four-tenths of a penny per ton of goods per mile, an arrangement which lasted till 1840. He thus obtained full independence of action, and was able to open works of his own at Shildon. During the next seven years he turned out a large number of locomotives. He designed and built the Magnet for the Stockton and Darlington Railway in 1835, and the Enterprise, from the same plans, was built by W. and A. Kitching. These were of the Wilberforce class, but more powerful, while the boilers had 110 boiler tubes. The first engine ever sent to Russia was built by him in 1836. It was a fire-box engine, its chief peculiarity being a long crank and short stroke known as a double trunk engine. An engine very similar was supplied by him to the Stockton and Darlington Railway in 1837, called the Arrow, which ran for many years. Other engines designed and built by him up to 1840, included the Beehive, the Briton, the Tory, Auckland, Despatch and Dart. The Beehive and Briton had vertical cylinders similar to the Magnet. The Tory, 1838, was the first of a new type, with sloping cylinders bolted on either side of the trailing end of the boiler, and the Middlesbrough, Ocean, and Etherley, built by William Lister of Darlington, were copied from it. The Whig and Tees were also copied from the Tory, and built by the brothers Kitching. Hackworth built four engines for South Hetton Coal Company, and two for the Clarence Railway. In 1838–39 three were sent to Nova Scotia, the Samson, Hercules and John Buddle, the first locomotives in British North America, which ran till 1882, and one of which, the Samson, was under steam at the Chicago Exhibition of 1893.

In 1840 Hackworth ceased his connection with the railway, but continued building locomotives at his Shildon works till his death in 1850. During these later years he built the Coxhoe and the Evenwood for the Clarence Railway, the Leader and the Trader for the Stockton and Darlington Railway in 1842, also locomotives for the Seghill Colliery Company, the John and Samson, and engines for the Earl of Durham's Railway, the Seaton Delaval Colliery, the Cramlington Coal Company, the Stanhope and Tyne Railway and the Llanelly Mineral Railway Company. Twelve locomotives for the London and Brighton Railway were built during 1846–48, and his last engine, the Sanspareil No. 2, was completed in 1849, a six-wheel single driver, which, after his death, was purchased by the North-Eastern Railway, on which it ran for many years, being remodelled in 1878.

An engineer's career, merely summed up in the number of locomotives he has built, is necessarily incomplete. And while any claim to distinction put forward on behalf of Hackworth must of necessity depend upon his engineering achievements, his life's work would be incorrectly portrayed if it did not include some account expressed other than as engine output. He was not only a great engineer, but an upright, honourable man, who, while absorbed in his work, yet found time to do a vast deal for others. Till he went to New Shildon, in 1825, the place had no existence. As the township grew, he was the acknowledged head, and held sway there for twenty-five years. He was a kind and sympathetic master, who earned the respect and affection of his men, and among them labour troubles were unknown. Out of the heterogeneous

material which made up the population of that early railway village, he raised a class of mechanics whose skill became famous, and an apprenticeship under Timothy Hackworth was at once an education and an assurance of work elsewhere. But he did more than provide work for them. He looked after their religious needs and their recreation.

Hackworth's education was that of the village school, where he remained till he was fourteen, when his seven years' apprenticeship began. He was ever a diligent student, deeply interested in scientific subjects, and became a member of the British Association for the Advancement of Science in its early days. His position at New Shildon brought him into touch with many of the leading men of the day, the entertainment of whom was a great pleasure to him. He had all the hospitality of the North countryman, and delighted to gather round him people in various walks of life, and possessing a considerable fund of information and a strong sense of humour, we may reasonably presume the pleasure was mutual. He found his fullest occupation in the busy if confined area of which his home was the centre. In his young days he had been an accomplished dancer, and though the art was not encouraged by his religious friends, he taught all his children. He delighted in music, in which his daughters were carefully trained. Another of his recreations was gardening, to which he devoted such spare time as he was able.

His engineering establishment was called Soho Works, the name being suggested by Joseph Pease, jun., to whom he was greatly attached, and with whom a sincere friendship lasted through life. Both with Joseph Pease, and his younger brother Henry, his relations were always of the happiest kind.

In appearance Hackworth was a tall, handsome man of fine physique, well developed by his early trade as a smith. He came of a tall race, stood over six feet high, and always maintained an erect figure. His features have been described as those of a poet saint rather than a practical engineer. An old Stockton and Darlington driver said, "He was a fine, tall, majestic man, a real gentleman, who never let a wrong word pass his lips. His appearance," he added, "was such that I think no man ever passed him without a respectful salute." He was never a wealthy man. He had not the money-making instinct, which few men with the inventive faculty possess, and he was of a generous nature, known as an open-hearted and open-handed man. What Hackworth lacked was the spur of personal ambition, a trait which may sometimes be well dispensed with. It would have brought him more prominently before the world, but to his death in 1850, at the age of sixty-four, he remained a humble-minded man, indifferent to public applause, and content that the work he had accomplished should speak for itself.

As for that work with regard to the locomotive, I will close this too hurried review in the words of the late D. Kinnear Clark, who wrote, "No single individual in this country had, up till the year 1830, done so much for the improvement of the locomotive and for its establishment as a permanent railway motor as Mr. Timothy Hackworth."[25]

[1] Paper read before the Newcomen Society at Caxton Hall on March 1st. Abridged. The author is a grandson of Timothy Hackworth, and some of the particulars given are drawn from family knowledge.

[2] *Practical Mechanics' Journal*, "Memoir of Timothy Hackworth," page 225, Vol. III., 1850–51.

[3] John Hackworth's List of Timothy Hackworth's Inventions.

[4] *Practical Mechanics' Journal*, page 225, Vol. III., 1850–51, "Memoir of Timothy Hackworth."

[5] "Proceedings," Institution of Mechanical Engineers, May, 1890, page 182.

[6] "Proceedings," Cleveland Institution of Engineers, March, 1886, page 14.

[7] The Diaries of Edward Pease, page 380.

[8] THE ENGINEER, August 14th, 1857.

[9] Smiles' "Lives of Geo. and Robert Stephenson," 1862, page 250.

[10] Jeaffreson's Life of Robert Stephenson, 1864, vol. I., page 101.

[11] "The North-Eastern Railway," by W. W. Tomlinson, page 138.

[12] *Practical Mechanics' Journal*, June, 1850.

[13] J. W. Hackworth in THE ENGINEER, August 14th, 1857.

[14] *Practical Mechanics' Journal*, June, 1850.

[15] Timothy Hackworth to Robert Stephenson. Draft of original letter in the writer's possession.

[16] "The North-Eastern Railway," by W. W. Tomlinson, page 144.

[17] *Ibid.*, page 151.

[18] THE ENGINEER, October 23rd, 1857.

[19] Minutes of Sub-committee, October 31st, 1828.

[20] "The North-Eastern Railway," page 136.

[21] "Reports to the Liverpool and Manchester Railway Directors," by James Walker and J. U. Rastrick, page 17.

[22] "Arcana of Science and Art," 1830, page 11.

[23] See Timothy Hackworth's etter to the directors of the Liverpool and Manchester Railway.

[24] Wood's "Treatise on Railways," third edition, page 506 *et seq.*

[25] "Railway Machinery," by D. K. Clark, page 9.

UNIVERSITY OF NANCY: SUMMER HOLIDAY COURSE IN ELECTROTECHNICS.—We have received from the University of Nancy the syllabus of a holiday course of instruction in electrotechnics, which will be held in the Electro-technical Institute in that city from Tuesday, July 18th until Tuesday, August, 22nd, 1922. The course, which will be under the direction of Monsieur Pocas, will include (1) direct current; (2) alternating current; (3) applications; (4) practical work and tests; and (5) visits to electrical manufacturing works and central lighting and power stations. Further particulars may be obtained from the hon. secretary, British Bureau, Office National des Universités, Engineering Department, 45, Great Marlborough-street, S.W. 1.

THE INSTITUTION OF CIVIL ENGINEERS: LONDON STUDENTS.—At a meeting of the students of the Institution of Civil Engineers on Wednesday, February 22nd, a paper, "The Fundamental Principles of Locomotive Design," was read by Mr. E. A. Phillipson, Stud. Inst. C.E. A good discussion followed, points being raised by the following students:—Messrs. Brown, Braithwaite, Sharp, Molloy, and McDonald. Mr. A. J. Hill, M. Inst. C.E., who was in the chair, in his remarks spoke of the great limitations of height, width and axle load, &c., imposed on English railway engineers. At the conclusion of the meeting Mr. Wallace proposed and Mr. Howe seconded a vote of thanks to Mr. Hill for acting as chairman.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

An Engineering Lock-out.

THE employers' ultimatum on works management came as a shock to the officials of the Birmingham district branch of the Amalgamated Engineering Union, who were under the impression that negotiations had not been concluded. The attitude of the mens' leaders locally is one of hostility to any interference with the concessions obtained during the war. In the Birmingham and Wolverhampton area, about 30,000 skilled craftsmen are normally employed in the engineering industry. Many of these men are at present out of work, but it is believed that no fewer than 20,000 men are actually affected by the lock-out notices which have been posted. Among the Birmingham and district employers, the feeling is that a vital principle is involved in the insistence of the Amalgamated Engineering Union upon interfering with the functions of management. For many years socialists have been clamouring for a share in the control of industry, and the engineers by their ballot have expressed their intention of holding to the position they won at a time when wholly abnormal conditions prevailed. On the other hand, the employers are resolved to be "masters in their own house," and are now determined to set their faces against the continuance of conditions which were forced upon them at a time of grave national danger.

The Proposal to Withdraw the Bonus.

The Amalgamated Engineering Union is not affected by the negotiations now proceeding on the proposal of the Midland employers to withdraw the 26s. 6d. bonus. The unions concerned in this matter are the Workers' Union and the National Federation of General Workers. A further conference was held last week end, and after a long discussion, it was decided that the following modified proposals of the employer should be laid before the executive councils of the unions. The employers' final proposal is (1) a reduction of 6s. per week from the beginning of the pay week on or following March 13th; (2) a reduction of 6s. per week, May 1st; (3) a reduction of 4s. per week, June 19th; (4) no further alteration until after discussion with the unions. The representatives of the unions gave an undertaking to let the employers have their final answer on March 6th. In the meantime the present rates will be maintained.

The Allied Section of Engineering Trade.

The possibility of the basis of agreement on the question of the allied section of the engineering industry in the Birmingham and Wolverhampton area is indicated. Originally the employers submitted a list of seventeen or eighteen industries, but out of this list has now been taken, as a result of negotiation, cycles, dropped stamps, and forgings, and a number of others covered by trade boards. At a week-end meeting, Mr. G. E. Geoby, of the Workers' Union, submitted that in view of the fact that important industries had been withdrawn from the list by the employers, the basis of an agreement had been reached. The result of meetings now being held by the unions concerned, is to be made to the employers in a week.

Staffordshire Bar Iron Prices.

Local ironmasters are much disappointed with the small proportion of business obtained as the result of the numerous inquiries lately received. Apparently, the recent reductions have failed to satisfy the buyer, who is still clamouring for lower prices. Par quotations tend to weaken, good quality Crown bars being this week obtainable at £11 10s., which is 10s. below what is regarded as the official figure. Cutting is pretty widely in evidence in the common bar trade, owing to the keen competition for the restricted amount of business available. To combat the efforts of Lancashire makers to secure business here some local makers of nut and bolt and fencing iron have this week reduced their quotation by 5s. per ton, bringing the price down to £10 15s. Belgian bars are still on offer at £9 10s., delivered Birmingham. The quality is not equal to that of Staffordshire, and such purchases have an element of uncertainty, as they are subject to market fluctuations, delays in delivery, and the invariable condition of cash on bill of landing. In the galvanised sheet trade the demand is rather poor, but slightly higher prices are asked for galvanised corrugated sheets, recent quotations having been found unremunerative. Local mills are meeting with keen competition from South Wales in black sheets, one firm quoting them at £10 10s., which is at least £2 below the local figure. The fall in the bank rate is welcomed as an aid to business revival.

Staffordshire Steel Hoops at £12.

Steel values lack stability, and this week, Staffordshire steel hoops have fallen to £12 per ton. Firms which own no allegiance to any association are not bound by any basis. There is no foreign competition to speak of, and the struggle for business remains between the home producers. Small bars are as low as £9 5s., and billets are about £7 5s.

Increased Activity in the Pig Iron Trade.

The improvement in the pig iron situation is maintained, and, indeed, considerably more activity is reported this week. This is expected to lead to increased output. Midland smelters have negotiated a number of orders for fairly large quantities during the past week. More furnaces are being put into commission. A second furnace has been started in Apedale, North Staffordshire, and another at Hanley is expected to recommence shortly. One of the most easily recognisable effects of the stemming of imports from Belgium of pig iron is a tightening up of the market for basic pig. The prevailing price is about 82s. 6d. There has been no relaxation of the tension which developed a fortnight or so ago with regard to coke and which is attributed to the shipment of substantial consignments from our ports to France and various destinations in Northern Europe. Furnace cokes are quoted at about 2s. more than formerly. In some cases the coke oven owners are asking as much as 5s. per ton increase which, it is estimated, would add something like 8s. 6d. to the cost of pig iron production. In spite of this, the easing of pig iron values has continued. Smelters have found rather freer outlets for both foundry and forge qualities this week, but in their dread of adding to stocks they have reluctantly yielded to the pressure of consumers rather than miss a chance of doing business in what is still an irregular market. Derbyshire No. 3 is still quoted at 85s., nevertheless, 82s. 6d. has been accepted, and something lower is mentioned. Northamptonshire furnace owners are ready to close at 80s. Forge qualities rule quite half-a-crown lower than a week ago.

Malleable Iron Founders' Association.

At the first annual banquet of the Malleable Ironfounders' Association, held in Birmingham last week, it was regretted that the Association had not been as successful as was anticipated. Mr. W. H. Proctor, the chairman, said that the object of its members was not to create a monopoly, or to make such charges for their products as would give an unfair return. Before the war, and to a certain extent during the war, the industry was placed at a disadvantage owing to the lack of proper organisation. They were engaged in one of the most difficult industries in the country, and it was not fair that capital and brains should be expended in the way they had been without an adequate return. In the majority of the malleable iron concerns, the principals were often the hardest worked men, and often they were inadequately rewarded. To-day, may firms were actually losing money. That state of affairs could be remedied to a large extent by organisation. Mr. Charles Retallack, who emphasised the need for combination, said that he was informed that in the Birmingham and Wolverhampton districts there were over thirty employers' associations engaged in various ironfounding, engineering, and metal trades. They were all "working branch lines, and were pushing barrows and hand-carts down by-lanes." All that meant confusion. Federation of thought, action, research, labour and capital would bring a deeper knowledge and the highest industrial results. He was convinced, he said, that the malleable ironfounders of Great Britain were resolved that they would not rest, either in research or mechanical exactitude, until the highest results were obtained both in quality of material and finish. There was abroad a spirit of universal aspiration for the best. Mr. P. J. Haunon, who also referred to the importance of trade organisation, went on to speak of the burden of taxation. Unless, he said, there was a substantial reduction in taxation in the near future, many industries would be throttled. The economic tragedy which faced us at the present time was not to be attributed to any other cause so much as the burden of intolerable taxation which had been placed upon the shoulders of the manufacturers since the Armistice.

Birmingham's £100,000 Electricity Scheme.

The Birmingham Electricity Committee has approved a scheme for extending its service to the outside areas on the east and south sides of the city. The total cost involved is about £100,000. The proposal is to run a high-tension main through Ward End, Stechford, Yardley, Acocks Green, Hall Green, Alcester Lanes End, Kings Norton, Cotteridge, Northfield, and Selly Oak, to Weoley Park. Transformer stations will be employed to reduce the high-pressure current to a suitable pressure for consumption.

Warwickshire Coalfield Difficulties.

During the past week, negotiations have been in progress between the owners of three or four of the Warwickshire collieries and the miners, on the question of the reduction of the present rate of wages. The position of affairs, as represented to the men, is that unless a reduction is effected in the district rate some of the collieries in the Warwickshire area will have to be closed down. The possibility of this step having to be taken has been realised by Mr. W. Johnson, the general secretary of the Warwickshire Miners' Association, who has declared that everything possible must be done to prevent any of the pits closing, and he expressed the hope that every effort would be put forward by the colliery owners and the workpeople to co-operate in this direction. The wages paid in the Warwickshire collieries are regulated by the Eastern District Federated Area, but so far no representations have been made to this body. The negotiations are well advanced, and are proceeding smoothly, but no definite agreement had, up to the time of writing, been reached.

Unemployment Decreasing.

Employment in Birmingham and the Black Country is steadily increasing and each week now sees more of the workless absorbed into local industries. The latest figures for Birmingham show a reduction on the unemployed register of about 1300, the numbers dropping in one week from 85,724 to 84,464. In Wolverhampton, the latest figures published are the lowest on record since March, 1921. On the week there has been a reduction of no less than 1145 in the number of persons registered as unemployed. The four figure decrease is principally accounted for by short time workers going on full time. Of these, 40 per cent. are edge-tool workers, 30 per cent. in the engineering and motor industry, and 30 per cent. engaged in miscellaneous trades. So great a week's decrease has not been experienced in Wolverhampton during the whole of 1921.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

VARIOUS rumours of slight improvement here and there, in the iron and steel trades, are heard in Manchester, but they do not produce any effect upon Manchester opinion. In truth, few if any, Manchester men believe that there is anything in them; and yet a real improvement in trade must begin much in this tentative way. Probably the truth is that the Lancashire iron and steel trade will be one of the last sections of the industry to revive, because it is more heavily handicapped by the high railway rates than the centres of the trade at or nearer the coasts. It would, however, be easy to take these rumours too seriously, for we have yet a long and weary road to travel before the iron and metal trades of the country can be restored to anything approaching the prosperity they enjoyed in pre-war days.

Metals.

The market for standard copper has shown a good deal of activity as a result of the recent heavy fall in prices. A considerable amount of buying has occurred, while the prices have been coming down, but this seems to have been almost entirely of a speculative character. The actual consumers of copper have not yet begun to buy in any quantity, and hence the general position is not improved, except, of course, that the level is lower, and hence so much nearer the bottom. The American market has been very weak, and the time is now not very far distant when many of the hitherto idle copper works are to come into operation. Should the market not be able to absorb more copper after April, we may again see a further accumulation of metal, and with an exchange approaching par, it may be offered from America at less than the very low prices now obtaining here. Our readers will realise that if the present American price, say 12¼ cents per lb., is no higher when the exchange touches par, then American electrolytic could be put in warehouse here at about £60 per ton. The demand here for copper from the engineering trade is quite insignificant, and the German demand is now not so good as it was. Some people talk of a revival in the spring, but one doubts whether there is much chance of this. If there were signs of it they should be seen by this time. The official prices for manufactured copper and brass have been reduced slightly, bringing strong copper sheets to £90 per ton, copper locomotive tubes to 1s. 1½d. per lb., and brass locomotive tubes to 11¾d. per lb. The difference between locomotive and condenser tubes, viz., 3d. per lb., is still maintained. The demand for tin, like that for copper, is in no way improved, but the sharp fall in the prices last week led to a large amount of speculativp business, thus giving an appearance of activity to the market. One does not see that the outlook is any different, but if any further fall should take place, it may disturb the feeling in the East, and lead to nervousness about the high-priced stocks which are being held back. The sharp fall in lead is probably arrested for a time, and there may be some reaction, but consumers are probably right to buy only what is needed for immediate use. The total amount of the fall since the beginning of the year is 20 per cent., and this is probably enough for the present. The stocks of lead in this country are not so large as they were, but there is enough to provide for all needs in the present state of trade. Spelter has been a steady market, with a slight tendency to improve. There has been more inquiry from France, but the galvanising demand here is only moderate, and that from the brass makers is poor.

Foundry Iron.

The demand here for foundry iron continues on a small scale, and buyers content themselves with ordering lots as they are wanted. The aggregate of business seems now to be enough to keep the Derbyshire furnaces which are working fairly clear of any accumulation, but this is mainly because there is no competition for Manchester orders from the furnaces in North Staffordshire and Lincolnshire—which remain idle. The prospect as regards foundry iron prices here depends upon whether furnaces will remain idle until the rate of consumption increases. In that case, perhaps buyers need not expect any fall until it is possible to make foundry iron at a lower cost. There has been lately an upward tendency in furnace and foundry coke, and this prevents any immediate prospect of cheaper foundry iron; but one cannot believe that there can be any permanency about a rise in fuel in the present state of general industry. The prices quoted on the Manchester Exchange for No. 3 common foundry pig iron are from 92s. 6d. to 95s. per ton delivered. There is some sale of Scotch foundry iron going on at 117s. 6d. to 120s. per ton, but the difference seems excessive, and Manchester consumers rather resent it. They want to get back to the time when Scotch No. 3 cost 5s. more than Derbyshire No. 3.

Finished Material.

There has been no further change in the prices for finished iron here. The Lancashire makers quote £12 per ton for Crown bars and £11 (in some cases £10 10s.) for a so-called second quality. In sectional steel the old fixed prices remain in force for the home trade, but there is only a small amount of business in the district. The prospect of an engineering dispute may perhaps prevent some buying. On the other hand, more business is being done for export, but of course, at prices which do not pay.

Scrap.

The market remains dull for all kinds of scrap, although it is said that steel scrap is slightly better than it was. Lancashire is, however, a bad place for it, especially now that the railway rates are so high. Dealers talk of 47s. 6d. per ton for heavy steel melting scrap, but a short time ago they were talking of 45s. The ironworks are offering 65s. per ton for heavy wrought scrap. Foundry scrap ranges from £4 to £4 15s. per ton, the latter being the price for broken textile machinery cast iron.

Technical Library for Manchester.

For some years there has existed a consensus of opinion that a really comprehensive and up-to-date technical library is badly needed in Manchester. The subject has been discussed from time to time, but the war period prevented any progress being made with the proposal. With the object of revitalising the subject, Mr. Daniel Adamson invited a number of gentlemen to dinner at the Engineers' Club last week. These included Alderman Abbott, the chairman of the Libraries Committee of the Manchester Corporation, Mr. L. S. Jast, the chief librarian; Mr. Allott, the chairman of the local section of the Institution of Civil Engineers; Mr. Charles Day, chairman of the North-Western Branch of the Institution of Mechanical Engineers; Alderman F. West, President of the Manchester Association of Engineers; Alderman Walker, chairman of the North-Western Branch of the Institution of Electrical Engineers; Mr. H. Allcock, director and hon. secretary of the engineering section of the Manchester Chamber of Commerce; Mr. Clayton, of the Society of Chemical Industry; and Mr. J. S. Webb, President of the Engineers' Club. Mr. Adamson mentioned that the engineering firms and societies had started the nucleus of a technical library, which was much appreciated. He said, too, that the corporation housed the books which had been lent by private individuals and societies, whose property they still remained. They were available, he explained, for reference purposes by the general public, and the books were placed in special bookcases provided by the societies. They were lent out to any members on making application on presentation of a card of membership. Those present at the meeting agreed that such a scheme would be welcome for Manchester, and it was considered likely that all the technical societies which meet in Manchester might be disposed to hand over their collections of books and "Proceedings" to the corporation so as to form one comprehensive library, to be housed in the library building situated in Piccadilly. The general idea had the cordial approval of Alderman Abbott, who promised to bring any proposals before the Libraries Committee, and to give all the assistance he could to further the scheme. During the informal discussion which took place round the dinner table, it was mentioned that many private firms might assist the scheme by subscriptions and donations either of books or money, and that in return for these, an up-to-date card system might be evolved, whereby the firms could periodically be notified of the latest books and information forthcoming on subjects in which they are specially interested. It was also agreed to accept Alderman Abbott's invitation to pay a visit of inspection to the Commercial Library which has been provided by the Manchester Corporation in the Royal Exchange building, and afterwards to visit the premises in which it is proposed to accommodate the new technical library.

Steel Works Bricklayers' Strike.

Work in the Lancashire steel works is being held up by a strike of bricklayers who are employed in making good the constant wear and tear of furnace linings. The origin of the dispute is an agreement made between the Iron and Steel Ingot Makers' Association and the workers' unions concerned, whereby the wages of the men employed in the steel works were based upon the selling price of steel, this price being ascertained and fixed at three monthly intervals. Owing to the great depression in the steel making industry the wages of the bricklayers were reduced in November last by 15s. per week, and last month a further reduction of 11s. was made, bringing the wages down to 8d. per hour below the national building trade rate. It was in consequence of the second reduction that the strike came about, and thousands of steel workers are thrown out of work. An attempt was made last week to settle the dispute, but unfortunately it ended in failure. The employers proposed that the wages reduction of 11s. per week should be made by instalments, 4s. to come off immediately, 4s. on March 12th, and the remaining 3s. on April 9th, this arrangement to remain in force until May 7th, the date of the next ascertainment of the selling price of steel on which the men's wages are based. The workers decided that the terms offered were unacceptable, and so the strike continues.

Gasworks' Extensions.

The Manchester City Council is about to apply to the Ministry of Health for consent to borrow a sum of £477,108 to carry out proposed extensions of the Bradford-road and Droylsden Gasworks.

The Engineering Industry.

Although on all hands the hope is expressed that a way will be found to obviate the lock-out on March 11th, the employers are unanimous with regard to the decision they have arrived at on the subject of shop management, and the paucity of the number of votes registered by the members of the Amalgamated Engineering Union may be taken as a recognition by the men that the demand on the part of the employers is both logical and reasonable. The Manchester Engineering Employers' Federation embraces some 200 firms employing probably over 30,000 workpeople, so that the matter of a lock-out is one of great gravity in this district. The most serious side of the matter is the lack of confidence which the action of the members of the Amalgamated Engineering Union has brought about by refusing to recognise the decision of their executive, whose authority is undermined and whose position is rendered impossible.

A Prosperous Firm.

In these lean times, it is peculiarly satisfactory to hear of firms that are not feeling the pinch of bad trade. The shareholders in Mather and Platt, Limited, have reason to congratulate themselves upon a very good year, even better than that of 1920. Mr. L. E. Mather, the chairman of the company, at the annual general meeting held on Monday last, said that this satisfactory state of affairs, in spite of the present depression, was due in the first place to a large increase in the volume of turnover, and secondly to the profit, on the large amount of work-in-progress brought in from the previous year. The increased turnover was made possible by the firm's new extensions with their increased tool capacity, which were completed in time to augment the output and enable the firm to make deliveries before selling prices had fallen or stocks had depreciated to any serious extent. One of the most satisfactory features of Mr. Mather's remarks was with regard to the firm's relations with its employees. He said that the output per individual had increased compared with the output of the previous year, a fact which he attributed to some extent to the more settled condition of labour, and to the system of payment by results which is in force.

BARROW-IN-FURNESS, Thursday.

Hematites.

The position in the hematite pig iron trade of North Lancashire and Cumberland remains unchanged. The output is, however, somewhat heavier than of late, and in some cases the stores held in the hands of makers have been cleared, though there is still a fairly large tonnage held, taking all the district. There is no disposition as yet, on the part of buyers, to place orders for forward delivery, for they are content to cover their immediate wants. Fair orders are now held by smelters, and in Cumberland steel makers requirements are now heavier than for a long time past. A steady improvement in trade is looked for, but it will be gradual and will depend largely on a renewal of confidence all round. No price reductions are looked for for some time to come.

Iron Ore.

There is only a moderate demand for hematite iron ore, but the consumption is increasing locally, and it is to local smelters that trade is now confined. At the mines there is a lack of activity, and some of the larger undertakings are still idle. No imports of Spanish ore have been received in Barrow for several weeks.

Steel.

In the steel trade there is a little more activity to report. The rolling of rails has been resumed in the Workington district where fair orders are held. At Barrow the position is much the same. The demand for all descriptions of steel is very quiet and particularly for all classes of shipbuilding material. Hoops have been a steady business for some time, but it is a trade that has to be worked with much keenness.

Shipbuilding and Engineering.

These trades are in a very poor position. No new orders are coming to hand, and the contracts are gradually being worked out so that prospects are worse than they have been over a long period of years.

SHEFFIELD.

(From our own Correspondent.)

Hope Deferred.

WITH many of the manufacturers in this district it is rapidly becoming a case of hope deferred—and its proverbial consequence. The second month of the year passes with prospects but slightly improved—if at all—as compared with those with which the year opened. Without exception the heads of the big steel and engineering firms report that the signs of recovery, so far as Sheffield industries are concerned, are so slight as to be negligible. They claim to be optimists, and profess confidence in the ultimate revival, but week by week the realisation of their hopes seems to be no nearer. Their reports are only too well confirmed by the unemployment figures, which still remain in the near neighbourhood of 50,000. Here and there a spurt of work results from the placing of an occasional order, but these spasmodic instances are counteracted by the experience at neighbouring works where more men are discharged or suspended, so that the total does not appreciably vary from week to week. It was reported to me that coal merchants were selling much larger quantities of industrial fuel, but investigation showed that this is true only in isolated instances and to a few customers whose stocks had become seriously depleted or who had just managed to book a few orders. Such orders as are going relate only to urgent repair work that can no longer be deferred. There are no new enterprises being embarked on that will call for considerable supplies from Sheffield, and the railway companies are still very sparing with their orders, while shipbuilding, which in the old days provided Sheffield with a great and regular volume of work, is now practically at a standstill.

Unprofitable Blast-furnaces.

Certainly a few more blast-furnaces have been started—"and their owners wish they hadn't," was the comment thereon made to me by a responsible official of one of the largest firms here, which has a considerable stake in the iron trade. Indeed, I am assured that it is not at all unlikely that unless conditions very rapidly improve some of these furnaces may again be "set down," and considering the cost of putting the furnaces into blast this extreme step will not be resorted to unless the outlook is pretty hopeless. The hematite pig iron market has recently stiffened slightly as a sequel to the sale of several weeks' output of the furnaces, and it is said that Sheffield has bought on a larger scale than for some time past. But it is difficult to find any local evidence of the use to which this raw material is at present being put. Possibly the purchases may be indicative of a buoyant confidence on the part of a few steel makers, but it is to be feared that these instances do not reflect anything like a prevalent tendency. The call for common pig remains very quiet,

as the foundries have next to nothing to do. Steel scrap has, however, gone up in price, probably as the result of Germany's large purchases.

Export Trade Prospects.

Sheffield is now sending practically nothing in the way of steel products to America, but the export trade to the Far East and to the Australian market is said to be a little better. Trade with European countries is still, of course, practically impossible, but the prospects of this market are by no means being neglected by Sheffield manufacturers. While on the subject of foreign openings, it may be of interest to refer to the evidences of foreign competition which were provided at another exhibition arranged under the auspices of the Applied Science Department of Sheffield University. These samples of foreign-made light tools—mostly from Germany, America, Spain, Denmark, France, and Norway—have not greatly perturbed the Sheffield manufacturers who inspected them, for although the prices were invariably considerably below those possible for British products, the finish left much to be desired, though German forging appears to be superior to that of our shops, with the result that much less time is required for the finishing processes, and the article can thus be produced more cheaply. While local manufacturers and workmen are contemptuous of these poorly finished cheap articles, it has to be remembered that they are being offered for sale in this country in increasing quantities, and are evidently finding purchasers, and there are some among the well-wishers of Sheffield industry who are suggesting that a little less scrupulous care might be lavished in the articles of everyday use if this would enable them to be produced at a figure comparable with that asked for the foreign-made goods.

The Prejudice against Stainless Steel.

There has been a good deal of controversy during the past week concerning the selection of cutlery of the ordinary—one now writes, almost instinctively, "old-fashioned"—variety, as part of Sheffield's Royal wedding gift. Those responsible for this selection have provoked a storm of protest from those who maintain that stainless steel would more fittingly have not only represented Sheffield's sentiments to the recipients, but at the same time expressed in an official manner the city's confidence in this, its latest product to win world-wide fame. There has in the past been a certain amount of prejudice against stainless cutlery on the ground of its alleged inability to take and maintain a keen cutting edge. This has been shown to be a totally unfounded complaint against the material, and has arisen from the fact that, like all new things that take the public fancy, it has brought on to the market many cheap and nasty substitutes. There is not the least doubt that had the makers of the gift been asked to supply stainless cutlery they could have turned out something which in every respect—workmanship, utility and beauty—would have upheld the fame of the city and of the firm entrusted with the order. In view of the fact that the Corporation, through its Development Committee, has been associated with the propaganda by which stainless steel has been widely commended, it is felt that the civic authorities have shown an unfortunate lack of confidence in their own commendation in specifying the old-style cutlery for the wedding gift. The indebtedness of Sheffield in a commercial sense to the invention of stainless steel cannot well be exaggerated. It saved the local cutlery industry in a period of unprecedented slump; it created a new demand just when Germany was swamping the country with cheap knives, and there has been an enormous, and sustained demand for the new steel. When the city has the opportunity to proclaim its confidence in the invention it is, to say the least, strange that it should neglect this chance. The new steel is not, of course, a monopoly; there are many eminent firms who use it in the manufacture of cutlery and other commodities of the highest class, and its utility and durability are no longer questioned.

Scrap Supplies.

A considerable quantity of steel and other scrap will be provided as a result of a contract let to a local firm, Messrs. Marple and Gillott, for the purchase and breaking up of about half a dozen warships. The work on these warships will provide employment for about four months for a considerable number of men. H.M.S. Acorn is the first of the batch to be dealt with; she is a torpedo-boat destroyer of about 1000 tons displacement, built by John Brown and Co. on the Clyde in 1910. It is interesting to note that a good deal of the steel originally made in Sheffield for the construction of this ship will return to the city as scrap for re-melting and use in other manufacturing processes.

Lincolnshire Schemes.

Concurrently with the placing of some very satisfactory orders with Lincoln engineering firms, which will be very welcome in view of the large amount of unemployment in the district, there are several schemes projected by the local authorities of the county. Scunthorpe, which has in the last few years grown from an isolated agricultural village into a busy industrial town, thanks to the development of the ironstone resources in the neighbourhood, has in hand a new water scheme which includes a million-gallon reinforced concrete high-level reservoir, a trunk main and distributor mains and other works totalling in cost nearly £48,000. Tenders for the various contracts are being invited, and the work will be proceeded with as soon as possible. In South Lincolnshire—where a new water scheme is also being undertaken (as described in my letter last week)—the problem of main road repair has been given serious consideration. These roads have of necessity been neglected for some time past, and are scarcely equal to present-day traffic. Mr. Haller, the County Surveyor of Nottingham—whose main roads are perhaps unsurpassed in the kingdom—has been consulted, and has recommended a scheme whereby the reconstruction of the main roads can be carried out at £3770. The fifteen miles of main road between Boston and Spalding are accordingly to be reconstructed at a total cost of £52,600.

The Coal Position.

Cheap fuels being the basis of all industry, and of those of Sheffield in particular, the drop of 6d. a shift in the miners' wages in the Yorkshire, Notts., Derbyshire, Leicestershire, and Warwickshire area, which was decided upon at Derby on Monday as the ascertainment for the March rates, will be welcomed by manufacturers. Coal will, however, still be considerably above the 12s. per ton rate which an acknowledged authority in the steel trade tells me is really necessary before any marked revival can be hoped for. The inland consumption of industrial coal has not appreciably increased during the past week, though there is a little more export business being done. There is still a fair demand for slacks, as a consequence of the high price coke still commands, this latter circumstance being due to the heavy foreign demand for blast-furnace coke.

The Late Mr. James Marshall.

The death of Mr. James Marshall, head of the well-known engineering firm of Marshall, Sons and Co., will be a distinct loss to the engineering industry, and in particular to Gainsborough, the Lincolnshire town which witnessed the almost romantic development of this great enterprise. With his brother, the late Mr. Henry Marshall, who died sixteen years ago, Mr. James Marshall built up the works from a small engineering and millwright's business which was purchased by the father of the brothers in 1848. The business developed so rapidly that in 1862 it was formed into a private joint stock company, with Mr. Marshall and his brother as joint managing directors. It was chiefly through Mr. Marshall's energy and business acumen that the important Indian trade was developed, and the firm secured practically a monopoly in the manufacture of tea machinery. Other developments were taken in hand which led to the enormous extension of the works, which in normal times now employ a fourth of Gainsborough's population. The brothers Marshall established technical instruction in Gainsborough long before County Councils came into existence and erected and equipped a fine block of modern class-rooms for the use of the students. Mr. Marshall was a member of the Institution of Mechanical Engineers, a Justice of the Peace, an alderman of the Lindsey County Council, and in earlier years was associated with other public work in the town. He died on Sunday evening at Gainsborough, at the advanced age of eighty-six.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Strike Menace.

ANTICIPATIONS have once more been rudely upset. Just at a time when there was a perceptible brightening of the general industrial and commercial outlook there appears a cloud in the shape of a strike of bricklayers employed in the iron and steel trade in the North of England, and serious consequences are likely to arise unless there is a speedy settlement. Upwards of a thousand bricklayers ceased work on Saturday last. The men's union have been endeavouring to resist the reductions in wages which had been previously agreed upon, and in the course of last week the employers and the representatives of the men met in conference without arriving at a settlement of the issue. On the one hand, the position taken up by the employers is that they must abide by the recent arbitration on wages, while the point of view of the bricklayers is that the rates they now receive in the iron and steel trades are lower than those paid to bricklayers working on public or other work. It appears that the men contend for the application of the national building trade rate to all the bricklayers employed in the iron and steel works.

Cleveland Iron Trade.

There has been rather a reaction in the Cleveland iron trade after the brisk business of the past three or four weeks. During the past few days buyers' inquiries have been much less numerous, and a lull seems to have set in. The possibility of a stoppage in the engineering industry has scared off many prospective buyers of Cleveland foundry iron, but a much more potent factor has been the rise in East Coast hematite pig iron. Foreign buyers who were coming forward in increasing numbers for hematite seem to have lost all interest now that the price has gone up. It would appear that there is more business to be done, but it is all a question of price, and unless this is at bedrock it is futile to look for orders. Of course, ironmasters cannot be accused of profiteering, even if prices are advanced, as they are still stated to be losing money, but they, in turn, would do well to ponder over the fact that even a small advance seems to effectively kill trade. The first need is to get industry on its feet again, and to raise prices is hardly the method to accomplish that object. Still, the position of the ironmaster is very difficult. If he keeps his furnaces idle he has to face heavy standing charges; if he makes pig iron, he makes it at a loss. It is a choice of two evils, and on the whole the latter is probably the less. Still, the rise of coke has complicated matters. More furnaces would certainly have been in blast to-day had coke remained at the figure ruling last month, but several firms which had contemplated lighting up have had to stay their hand, owing to the fact that coke contracts could not be renewed, except at an increased figure. In consequence of this also there are again very definite hints that Cleveland pig iron prices will speedily be advanced. For the time being, however, the little Cleveland foundry iron which remains for disposal can be bought at the old prices, viz., No. 1 and siliceous iron, 95s.; No. 3 G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d.; and mottled and white, 75s.

Hematite Pig Iron.

East Coast hematite is now quite scarce. Makers are so well sold that they are not pressing for business, and to inquirers generally they quote 100s. for mixed numbers and 101s. for No. 1. Possibly these prices might be shaded, but only slightly.

Iron-making Materials.

Coupled with the extra cost of blast-furnace coke, which is now round about 30s. delivered at the works for good medium qualities, the ironmasters are confronted with a rise in ore freights, which spells dearer ore. For a Bilbao–Tees freight 8s. per ton is now offered, and on this basis best Rubio ore is firm at 26s. 6d. c.i.f. That is a figure which consumers are indisposed to pay, and consequently the trade is idle.

Manufactured Iron and Steel.

No improvement can be recorded in the manufactured iron and steel trade. It is most disappointing to find that with the spring at hand the demand both for home and abroad shows no expansion, and the bulk of the men and plant is idle. The makers seem determined not to cut prices for the home market, but it is still the fact that foreign steel is offered below home prices. On the other hand, for export orders the steel makers still quote well below the home figures, and are getting a fair share of the limited volume of trade.

Another Blast-furnace Restarted.

The Cargo Fleet Iron and Steel Company, Middlesbrough, has just started up one of its blast-furnaces. This furnace has been idle since the coal strike, and in the meantime such iron as the firm has required for steel mixing has been chiefly supplied from the Continent, eked out with scrap. But the cheap continental iron is no longer available, and the firm has therefore found it necessary to start and produce iron for its own use. There are now twenty-eight furnaces in operation on the North-East Coast.

The Coal Trade.

The Northern coal market remains firm in all departments of the trade, being supported by a continuous demand from abroad, as well as a steady home trade for prompt delivery. The immediate outlook is hampered by a lack of tonnage, and though a large quantity is expected to be released in the Baltic by the ice-breakers and the better weather, there are only a few boats on hand, with the result that an odd cargo is available now and then at slightly cheaper rates. Some important contracts have just been fixed up, including one of 40,000 tons of best steams from Tyneside merchants for the Norwegian State Railways for shipment during March and April. The quantities and prices are 7000 tons of Lambton and South Hetton best screened at 25s. 9d. per ton f.o.b.; 28,000 tons of Lambton and South Hettons at 26s. per ton f.o.b.; and 5000 tons of best Welsh steams (Nixon Navigation) at 26s. per ton f.o.b. The outstanding feature of these transactions is the very high prices paid, which are shillings per ton above anything that was thought possible a little while ago. This seems to give a fairly reliable index of the probabilities of forward values. Several good orders are in circulation, and it looks as if there is a likelihood of the present heavy demand for shipment being continued for a month or two longer, now that buyers abroad are becoming more and more willing to pay high prices to secure supplies. Best Northumberland steams are very strong at a minimum of 25s. for any approved brand, and this figure has been done for Tyne primes and offered again for March and April loading. Seconds hold very firm, with unscreened and smalls also well supported by an expanding outlet. Gas coals are strong for bests and other favoured classes, especially with any good brand able to command good figures. Coking coal is very scarce at firm prices, while there is a big run on bunkers, with full figures ruling for any date of shipment before April. The firmness in all sections of the coke market is being maintained, and supplies are still very scarce, with quoted figures remaining very high and still tending upward.

General Workers' Wages.

A compromise has been reached by the employers and representatives of the General Workers' Union regarding the wages of men employed at the steel works and ironworks on Tees-side. The employers have agreed to a modification in respect of the last cut in wages under the sliding scale, as a result of which, instead of a reduction of 8s. 9d. per week immediately, there will be a reduction of 2s. 11d. as from February 12th, another 2s. 11d. as from March 12th, and a further cut of 2s. 11d. from May 7th. The alteration refers to men whose base rate was 5s. per day and under, pre-war.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding: Small Production.

THE true state of the shipbuilding industry in the Clyde district is made more manifest by the returns for the month of February. Many vessels were held up owing to the war, and since the end of hostilities, with work proceeding on these contracts, a moderate launching average was maintained. For a long time now there has been a lack of fresh contracts, and the number of empty berths has been rapidly increasing. Consequently, the launching returns gave an erroneous idea, seemingly indicating a fair measure of prosperity. With a lack of new business a slump was certain. During last month the output only consisted of seven vessels of 20,598 tons aggregate, being little more than one-third of the January production. Only three of the vessels launched could be placed in the category of ordinary trading steamers, and practically accounted for the total tonnage launched. Of these, the chief were:—The Mulbera, twin-screw geared turbine, 9200 tons, for the B.I.S.N. Company, Limited, London, and the Aconcagua, twin-screw geared turbine, 7000 tons, for the Compania Sud Americana de Vapores, Valparaiso.

The output for the two months—January and February—has, owing to the record figures for January, only been surpassed on two occasions. Very little in the way of new work has been reported during February, only two contracts having been mentioned. Messrs. Lithgows, of Port Glasgow, have an order for a passenger steamer of comparatively small dimensions, and Fleming and Ferguson, of Paisley, are to construct a small dredger and two small barges for the Roumanian port of Sulina, on the Danube.

Markinch Enterprise.

The hydro-electric power scheme undertaken by the Balgonie Colliery Company, Limited, Markinch, Fifeshire, which will cost between £50,000 and £60,000, is nearing completion. This company has had a similar system in operation for some years, but in order to secure additional power, the present scheme was promoted. This scheme includes the utilisation of the water of the river Leven, which is conveyed for a mile by means of an open aqueduct to the power station, at which point a vertical fall of fully 40ft. has been attained. Messrs. John Miller and Co., public works contractors, Inverkeithing, carried the scheme through, and the plant, including two powerful turbines, was designed and constructed by James Gordon and Co., London.

Pig Iron.

While business has not increased to any great extent, there is apparently a brighter tone in the pig iron market. Inquiries are increasing a little, and a continuance of this movement would soon cause an alteration in conditions. At present very few furnaces are in blast, and makers are only producing to cover requirements, and practically nothing is going into stock. Hematite has been showing a little firmness, but foundry qualities are a turn easier.

Finished Steel and Iron.

The outlook in the steel and iron trades can hardly be said to show improvement. Inquiries are fair enough, but actual orders are of small bulk. Inquiries, too, such as they are, come chiefly from abroad, and home markets remain dull indeed. The situation in the latter is rendered still more difficult by the uncertainty in the shipbuilding and engineering trades. Orders in hand at the steel works are barely sufficient to maintain a minimum amount of employment, and in this connection the slow development of the export trade has caused considerable disappointment. Orders for steel plates are very scarce, and for export as low as £9 5s. per ton has been named for plates ¾in. thick. There are more inquiries for black sheets. Galvanised descriptions, however, are very quiet, though Far Eastern markets are taking small lots. There is little movement in the tube trade, and very small orders are passing for castings. Bar iron makers are doing their utmost to meet buyers, but are not reaping much benefit. The quotation for "Crown" quality bars remains about £11 10s. per ton for home delivery, but a good order could be placed about 10s. under that price. A fair amount of activity is reported from the steel re-rolling departments, and material for export is named about £11 per ton.

Coal.

The situation in the coal trade on the whole is a shade better. The volume of business has not shown a great increase, but indications point to a broadening out in various directions. In the West of Scotland round coal, which has been extremely quiet for some months, is beginning to show decided movement, and some very fair cargoes have been dispatched during the past few days. Drosses are not easily disposed of, but washed nuts maintain their activity. Scandinavia, France, and Italy have been buying in bigger quantities of late. The collieries in Fifeshire and the Lothians are well booked up for most descriptions of fuel, and when shipping tonnage is in better supply a larger turnover will be possible. Aggregate shipments for the past week amounted to 210,700 tons against 208,095 in the corresponding week in 1913. Home sales are still of a discouraging nature. Consumers generally are buying very sparingly and only for immediate requirements. House coal is doing fairly well, however, but in this trade prices are very fluctuating. For deliveries amounting to a ton and upwards the price per hundredweight is on occasion 4d. per cwt. less than the regular charge per hundredweight for good-quality fuel. The cheaper qualities are not moving off well. There is a tendency to further weakness in coal prices generally, though in the cases of nuts and pearls considerable firmness is noticeable. Coal freights have also been firmer of late, the rate from the Clyde and the Forth to West Italy having risen again to 14s. 6d., though on occasion 14s. 3d. is mentioned.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE conditions prevailing in the South Wales steam coal market are very satisfactory, inasmuch as the firm tone and the recent higher prices obtainable are maintained. Prices are at a level which should prove remunerative, provided that anything like reasonable outputs are secured. Best Admiralty large coals are quoted at 27s. 6d. per ton, and the probability is that the market will keep round about this figure for a little time at least; but it is almost certain that the views held in some quarters that coals will go to 30s. will turn out to be too optimistic. The inquiry from abroad is on the whole good, but many buyers have missed their market, and are now coming on for supplies at prices which would have been all right a fortnight ago, but which are now too low for exporters to accept as they would only mean a loss. Quite apart from the improvement in coals the freight market has not only maintained its steady appearance, but rates have advanced for the direction from which the demands for coal are fairly plentiful, viz., Italy. All such inquiries do not, of course, materialise, but business which was placed some weeks ago has to be carried out, and some of the exporters have recently become pressed for tonnage, and have had to pay up to secure their requirements. Compared with a month or so ago, the rates for West Italian ports have gone up about 2s. per ton, and this, added to the fact that coals have advanced more like 3s. per ton, is proving a serious matter for those contractors who failed to cover themselves for their coal requirements. The comparatively sudden accession of strength to the coal market has, of course, its unfortunate aspect from the collieries' point of view, inasmuch as large scale operations for delivery over a long period as, for instance, six or twelve months, are checked. Buyers will naturally prefer to take only their barest requirements and wait for prices to relax before they commit themselves to supplies of substantial quantity. Expectations that the Norwegian State Railways would not take a very large portion of the coals they need from this district have turned out to be correct. The total quantity which firms were asked to quote for was 40,000 tons, but of that amount only 5000 tons of the order has been placed for one of the best Admiralty large coals, double-screened. The firm which has taken the business quoted 26s., but the coals which have to be shipped cannot to-day be bought under 27s. 6d. per ton. It is certain that the firm in question could not have covered itself with the colliery at the price at which it took the risk, so that the business in this case cannot turn out satisfactorily.

Shipment Facilities.

The Secretary of the South Wales Coalowners' Association has returned to the fray in the matter of the coal shipment facilities at local ports, and in the course of an article he states that the conditions which have governed the export trade during the past few weeks have revealed the urgency of the needs for improved facilities. The foreign coal trade of South Wales has made remarkable strides in the direction of increased volume since last July, but the reports received from the colliery companies as well as from coal exporters drew attention to the fact that the volume of trade would be appreciably greater if facilities were more efficient, but particularly if working hours at the docks were better adjusted to the changes in the character of the trade which have taken place since the present system of two continuous shifts was secured by the tippers and trimmers under the award of a Court of Inquiry in June, 1920. In 1913, shipments were made during the whole twenty-four hours, but in June, 1920, the present arrangements of two continuous shifts from 6 a.m. to 2 p.m., and from 2 p.m. to 10 p.m., was introduced. Since then foreign exports have increased from 1,300,000 to 1,800,000 tons per month, and foreign bunkers from 220,000 to 375,000 tons. The difficulty to-day is that the docks are unable to deal with the increased exports. The rate of output is greater than the rate of shipment, and in spite of full stems the collieries are losing time in consequence of the failure of the docks to absorb the supplies available for export. It is in the power of the dock workers to relieve this very serious situation, and thereby improve the economic position of the miner by agreeing to such alterations in labour arrangements as will permit of a greater daily volume of shipments. The loss of work at a colliery, for instance, owing to the congestion on the sidings or a shortage of empties, adds enormously to the cost of production, and thereby hinders the wage-earning power of the miner. Moreover, by such increases in cost, the competitive position of South Wales in relation to that of other coalfields is prejudiced, and that to the injury not only of the miners and the coalowners, but also of all capital and labour engaged in the Bristol Channel export trade.

Chemical Workers' Strike.

Chemical workers in South Wales having refused to accept a reduction in wages demanded by the employers, the result is that numbers of the workmen are on strike. In the Swansea area all the works are idle with the exception of those at Pontardulais which, with others in the Eastern district, are expected to be idle on Monday next unless there is a marked change in the position. The men belong to the Dockers' Union, and, according to one of the leaders, the men's representatives have explored every avenue making for peace but without result. He says that really the men should have struck three weeks ago, but they gave the employers every opportunity of averting a stoppage. Both locally and nationally, they had offered an inquiry or arbitration, but on each occasion the intimation that no outside interference would be tolerated. The National Council meets on Thursday of this week, but up to the present there is no indication of the employers receding from the attitude they have taken up. It is understood that the workmen in the Monmouthshire area and at Cardiff and Bristol have decided to throw in their lot with the men who have already come out. The effect of the stoppage of the chemical works will be serious for the tin-plate and kindred trades if it is of long duration. The acid produced in the chemical works is an absolute necessity in tin-plate manufacture. Supplies might be procured from England, but this procedure would add severely to the cost, and with the price of tin-plates already below cost of manufacture, would increase the losses of makers. This being the case it is probable that many manufacturers would rather prefer to close their works than to keep them running under such conditions.

Current Business.

The steam coal market keeps very firm, and colliery companies are very fully booked up for a month to come, and it is expected that the present favourable conditions will be maintained up to the Easter holidays. Collieries are in an independent position, and unless they can get good prices they are not disposed to sell. Best Admiralty large coals are 27s. 6d., and second qualities are 27s., while leading Monmouthshire large descriptions are quoted up to 26s. 6d. Superior highly bituminous large coals are practically unobtainable, and are nominally 30s. Small coals are scarce and firm. The best descriptions are quoted at 20s. to 21s., and even ordinary cargo sorts are about 18s. Patent fuel is firm at 25s. to 27s. 6d., makers being compelled to ask a higher price as their small coals cost them more money. As regards the anthracite market, the tone is not so satisfactory. The demand has fallen off and many collieries are in need of prompt orders. Best anthracite large is obtainable about 40s. to 42s. 6d., but second qualities can be secured at 7s. 6d. to 10s. less. Rubbly culm and duff coals are scarce, and colliery owners are declining to sell culm unless they can get an order for large coals. Rubbly culm is quoted at 12s. 6d. to 13s., and breaker duff is firm at 8s. 6d. Nuts, beans and peas maintain a relatively good tone.

Latest News from the Provinces.

LANCASHIRE.

BARROW.

Barrow Rail Mill Closed.

AT the Barrow Steel Works there is a strike of bricklayers, and as repairs cannot be carried out to the Siemens furnaces, the rail mill has ceased operations. The bricklayers demand to be put on the district rate in place of the sliding scale under which they have hitherto worked.

WALES AND ADJOINING COUNTIES.

Coal Inquiry.

The Bombay and Baroda Railways of India are in the market for 170,000 tons of Admiralty and Monmouthshire large coal, or alternatively for two-thirds large and one-third smalls, for delivery at Bombay between June and December next.

Swansea Metal Exchange.

Business on the market for tin-plates is very quiet, though makers hold the opinion that prices have rather an improving tendency. In view of the unremunerative character of the present prices, manufacturers are somewhat disinclined to accept orders of any substantial amount. The market for galvanised sheets is very dull.

CIVIL AVIATION ADVISORY BOARD.

THE Air Ministry informs us that the Civil Aviation Advisory Board, the creation of which was announced by the Under-Secretary of State for Air at the recent Air Conference, has now been set up with the following terms of reference:—"To advise generally on the development of civil aviation and to report upon any specific point which may, from time to time, be referred to the Board by the Secretary of State for Air." The constitution of the Board is as follows:—The Under-Secretary of State for Air (the Right Hon. Lord Gorell, C.B.E., M.C.), chairman; the Controller-General of Civil Aviation, Air Ministry (Major-General Sir Frederick H. Sykes, G.B.E., K.C.B., C.M.G.); the Director-General of Supply and Research, Air Ministry (Air Vice-Marshal Sir W. G. H. Salmond, K.C.M.G., C.B., D.S.O. Representatives of:—General Post Office (Brigadier-General F. H. Williamson, C.B.E.), Air League of the British Empire (Major-General Sir W. Sefton Brancker, K.C.B., A.F.C.), Association of British Chambers of Commerce (Mr. Edward Manville), Federation of British Industries (Mr. H. James Yates), Lloyds (Lieut-Colonel Sir Frederick Hall, K.B.E., D.S.O.), Royal Aero Club (Brigadier-General Sir Capel Holden, K.C.B., F.R.S.), Royal Aeronautical Society (Lieut.-Colonel Mervyn O'Gorman, C.B.), Society of British Aircraft Constructors, Ltd. (Sir Henry White Smith, C.B.E.) Mr. F. G. L. Bertram C.B.E. (Secretary). Air Ministry Arrangements have also been made for consultation, when required, with representatives of the Dominions. The Secretary of State has decided to refer to the Advisory Board, as the first subject upon which he desires its recommendations, the question of the cost and practicability of an Imperial air mail service. The Advisory Board held its first meeting yesterday afternoon, March 2nd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

JOHN RUSSELL AND CO., Limited, of Alma Tube Works, Walsall, ask us to state that they have opened a depôt for the sale of their products at Belmont Works, New Spring-street, Birmingham.

MR. R. WELBURY, ironfounder, late of Nook Foundry, Nook-street, Hillidge-road, Leeds, has notified us that he has moved into more commodious premises on the site of the Old Leeds Pottery, in Leathley-road, Hunslet.

WE are asked to announce that Mr. A. E. Wray, formerly of Dick, Kerr and Co., Limited, and subsequently of the English Electric Company, Limited, has joined the staff of G. D. Peters and Co., Limited, of 3A, Dean's-yard, Westminster, S.W. 1.

REAVELL AND CO., Limited, have moved their London office to larger and more commodious premises at 47, Victoria-street. Their telephone number, 5935 Victoria, remains as before. The head office of the business still remains at Ranelagh Works, Ipswich.

IN the Essex Motor Club's one-day winter trial, which was held on Saturday, February 18th, in Class II., for engines not exceeding 1500 cc., the four-cylinder 11.8 A.C. engine of Auto-Carriers, Limited, driven and owned by Mr. Kaye Don, was first. In Class 12, Mr. W. G. Brownsort, in a 15.7 A.C., was second.

THE INSTITUTE OF METALS.—The Secretary of the Institute of Metals, 36, Victoria-street, S.W. 1, desires us to say that he will be happy to send visitors' tickets to any engineers who desire to attend the meetings next week.

CONTRACTS.—Thompson Brothers (Bilston), Limited, of Bradley Engineering Works, Bilston, Staffs., have recently completed a contract for 20-ton oil and spirit rail wagon tanks, of their "Welded" type, for use on the Great Indian Peninsular Railway. The tanks were welded throughout, and all fittings were welded to the tanks. It is claimed that the tanks are the first of this type in use.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	23/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	26/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 5 0	—
No. 3 ,,	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	5 0 0	5 0 0
No. 1	5 1 0	5 1 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6	4 2 6
Mottled	3 15 0	3 15 0
White	3 15 0	3 15 0
MIDLANDS.		
Staffs.—		
All-mine (Cold Blast)	13 0 0	—
Part Mine Forge	*None offering.*	
North Staffs. Foundry (Nom.)	4 10 0 to 4 15 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 0 0	—
,, Forge	3 10 0 to 3 12 6	
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 15 0	—
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0 to 5 15 0	

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
SCOTLAND—		
Crown Bars	11 10 0	—
Best ,,	12 0 0	—
N.E. COAST—		
Common Bars	12 0 0	—
Marked ,,	17 10 0	—
Tees	14 10 0	—
LANCS.—		
Crown Bars	12 0 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
MIDLANDS—		
Marked Bars (Staffs.)	14 10 0	—
Crown Bars	12 0 0 to 12 10 0	
Nut and Bolt Bars	10 15 0 to 11 0 0	
Gas Tube Strip	12 10 0	—
Hoops (Nom.)	14 0 0 to 15 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ⅜in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 0 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
MANCHESTER (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 10 0 to 8 10 0	
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
MIDLANDS—		
Small Rolled Bars	9 10 0	—
Bessemer Billets	7 10 0 to 8 0 0	
Hoops	12 0 0	—
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (24 W.G.)	14 0 0	—
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 10 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/6 to 19/-
Block Tin (cash)	145 0 0
,, (three months)	146 15 0
Copper (cash)	58 15 0
,, (three months)	59 15 0
Spanish Lead (cash)	20 10 0
,, (three months)	20 7 6
Spelter (cash)	24 10 0
,, (three months)	25 0 0
MANCHESTER—	
Copper, Best Selected Ingots	62 0 0
,, Electrolytic	64 10 0
,, Strong Sheets	90 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	22 0 0
,, Foreign	20 7 6

(*Metal prices practically unchanged*).

FERRO ALLOYS,

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£68	34/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese	(per ton) £15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	22/-
,, ,, Ell	22/6
,, ,, Splint	23/6 to 25/6
,, ,, Trebles	24/6
,, ,, Doubles	22/6
,, ,, Singles	19/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	22/-
,, ,, Splint	23/6
,, ,, Trebles	24/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	20/- to 23/6
Screened Navigation	28/-
Trebles	25/6
Doubles	22/6
Singles	18/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	22/9
Secondary Steam	22/-
Trebles	25/6
Doubles	23/-
Singles	18/6

ENGLAND.

(8) N.W. COAST—	
Steams	33/-
Household	40/- to 55/-
Coke	32/-
NORTHUMBERLAND—	
Best Steams	25/- to 26/-
Second Steams	23/- to 23/6
Steam Smalls	14/- to 15/-
Unscreened	21/6
Household	25/- to 30/-
DURHAM—	
Best Gas	23/- to 23/6
Second	21/- to 22/-
Household	25/- to 30/-
Foundry Coke	38/- to 40/-

SHEFFIELD—	INLAND.
S. Yorks. Best Steam Hards	22/- to 24/- —
Derbyshire Hards	21/- to 22/- —
Seconds	21/- to 22/- —
Cobbles	21/- to 22/- —
Nuts	18/- to 19/- —
Washed Smalls	12/- to 15/- —
Best Hard Slacks	13/- to 14/- —
Seconds ,,	10/- to 11/- —
Soft Nutty ,,	9/- to 10/- —
Pea ,,	7/- to 8/- —
Small ,,	5/- to 6/- —
House, Branch	37/- to 39/- —
,, Best Silkstone	34/- to 36/- —
Blast Furnace Coke (Inland and Export)	17/6 to 25/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	27/- to 27/6
Second ,, ,,	26/6 to 27/-
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	25/6 to 26/-
Best Black Vein Large	26/- to 27/-
Western Valley ,,	25/6 to 26/-
Best Eastern Valley Large	25/6 to 26/-
Ordinary ,, ,,	24/- to 25/-
Best Steam Smalls	20/- to 21/-
Ordinary ,,	18/- to 20/-
Washed Nuts	27/6 to 32/6
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	20/- to 21/-
No. 2 ,, Large	23/6 to 24/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	16/- to 18/-
Coke (export)	32/6 to 35/-
Patent Fuel	26/- to 28/-
Pitwood (ex ship)	32/- to 32/6
SWANSEA—	
Anthracite Coals:	
Best Large	40/- to 42/6
Seconds	30/- to 35/-
Red Vein	29/- to 30/-
Big Vein	40/- to 42/6
Machine-made Cobbles	57/6 to 60/-
Nuts	57/6 to 60/-
Beans	47/6 to 50/-
Peas	20/- to 22/6
Breaker Duff	8/6 to 9/-
Rubbly Culm	12/6 to 13/-
Steam Coals:	
Large	22/6 to 25/-
Seconds	20/- to 22/6
Smalls	12/6 to 15/-
Cargo Through	18/6 to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Weaving Machinery.

A CONSIDERABLE amount of weaving machinery has already been imported for the equipment of the factories in the Nord, and a great deal more will be required as soon as the textile industry recovers from its present depression, owing largely to higher wages and shorter hours which are preventing manufacturers from selling cloth at prices that will enable them to dispose of their accumulating stocks. The fact of their charges having been heavily increased has compelled the textile firms to look for economies, and they hoped to find them by paying less for the additional machinery they will want to lay down when business begins to revive. An appeal to the Parliamentary Customs Commission to reduce the import duties on weaving machinery, which they declare to be absolutely prohibitive, is met by a reply from the General Director of Customs to the effect that the present duties are not more protectionist in character than they were before the war. Any reduction in the duties is further resisted by the French firms which have started upon the manufacture of textile machinery, their argument being that it is better to frame the fiscal tariffs in such a way that they would favour the exportation of manufactured goods rather than of raw material. The home textile manufacturing industry has certainly made headway, although several big firms which were induced by the Government to embark upon this branch of manufacture have given it up, but it is obvious that this artificial fostering of an industry that can only depend upon limited home requirements will never permit of the economical production of weaving machinery. It appears, therefore, that users of weaving machinery will continue to bear the burden of the protection accorded to a few home makers.

Alsace-Lorraine.

The official support given to the carrying out of public works in the restored provinces, notably the extensions of the port of Strasburg, and the facilities offered to enable the provinces to accommodate themselves to the new state of things, have not averted a commercial and industrial crisis, which, in the opinion of many, may have unpleasant consequences unless something is done to provide a remedy. The trouble began with the super-tax which was imposed on all goods from overseas entering France other than by French ports. Consequently, the trade that used to be done between Antwerp and Strasburg was seriously imperilled, and although a compromise was arrived at, the situation of Strasburg, which depends entirely upon the traffic to and from Central Europe, has been going from bad to worse. It was hoped that the inland port, which has considerably extended its capacity of late years, would find some compensation in the diversion of traffic to the rest of France, but unfortunately nothing has yet been done to provide Strasburg with new outlets, and it is alleged that the town has not only lost all its trade through the closing of old markets, but it is more heavily burdened with taxes and charges of all kinds than are other French towns. Further evidence of the feeling of unrest is the lock-out which has occurred at the works of the Société Alsacienne de Constructions Mécaniques. As a protest against a reduction in wages the men went on a "ca' canny" strike, with the result that the company closed down the works. In the town's electrical distribution works the men struck in sympathy, and thousands of hands have thus been deprived of employment in the textile and other industries in and around Mulhouse. The situation is complicated by the fact that while the cost of living has not declined to the same extent as elsewhere, manufacturers are obliged to reduce wages in order not to be placed at a disadvantage as compared with other French firms.

Coke.

The re-distribution of the iron ore deposits and coke supplies as the result of the incorporation of Lorraine into French territory is giving rise to a curious economic conflict between France and Germany. Before the war this country imported from the Rühr district about 3,000,000 tons of coke a year, and that amount is now barely reached by the consignments under the indemnity clause of the Treaty of Peace. At the same time, the capacity of metallurgical production has been doubled by the addition of the Lorraine basin, so that when the Lorraine blast-furnace owners have taken what they need there is very little left for the Moselle and the Meurthe-et-Moselle, of which the production is now only about one-third of its capacity. The efforts of the French Government to obtain control over the Rühr district is explained solely by the necessity of ensuring abundant supplies of cokes, which are procurable in only limited quantities from the Saar basin, and scarcely any at all elsewhere. On the other hand, Germany is assured of sufficient coke for her own needs, but the loss of Lorraine has seriously restricted the resources in iron ore. Before the war the Germans were so short of minerals that they coveted the basin of Briey. They are evidently hoping to create a state of things that will compel the French to supply them with Lorraine ores, for an active propaganda is being carried out in Germany whereby it is affirmed that the country is arranging for supplies of iron ore from Austrian and other sources, while it is even stated that contracts have been signed with Canadian companies which are, it is said, prepared to consign large quantities to Germany.

Locomotives.

About twenty firms have submitted tenders for the supply of thirty electric locomotives required by the State railways for the electrified line between Paris and Trappes; but as the State railways have decided upon employing one type of locomotives the whole of the order will probably be given out to one firm. The selection will be made amongst three groups representing Creusot, the Constructions Eléctriques du Nord et de l'Est and Fives-Lille. The section of line between Paris and Versailles is already practically terminated, and it is expected that the electrification of the section from Versailles to Trappe will be completed in two years, by which time the locomotives are to be ready for service.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

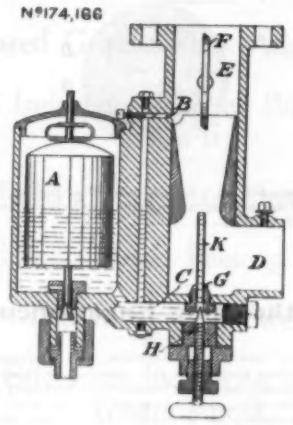
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

174,166. October 16th, 1920.—IMPROVEMENTS IN CARBURETTERS, C. Binks (1920), Limited, of Church-street, Eccles, Lancashire, and Charles Binks, Harold Binks, and Charles Leslie Binks, of the same address.

THIS invention relates to carburetters provided with a pilot jet for slow running and an adjustable main jet. The float A, and its chamber, the pilot jet B, the fuel passages C, the inlet pipe D, the outlet pipe E, and throttle valve F, are of ordinary construction. The main jet G is fitted with a needle valve H to

N°174,166



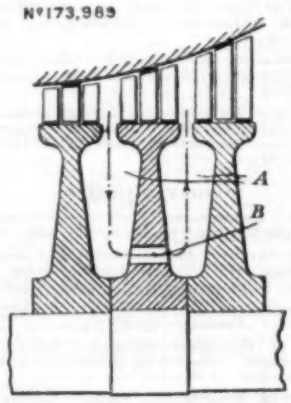
regulate the supply of fuel. To the main jet a reservoir jet K is fitted. This consists of a tube projecting upwards into the choke tube. When the engine is stopped or is supplied by the pilot jet C, the reservoir K gradually accumulates a supply of fuel, which, when the motor is started or accelerates, is drawn up more quickly than the supply from the jet G, thus temporarily giving a rich mixture at the critical moment.—*January 16th*, 1922.

STEAM TURBINES.

173,989. February 17th, 1921.—IMPROVEMENTS IN OR RELATING TO STEAM TURBINES, Karl Baumann, of Northwood House, Urmston, and the Metropolitan-Vickers Electrical Company, Limited.

The object of this invention is to provide improved means whereby the temperature of the various portions of the discs which support blades in a reaction turbine may be maintained at a practically constant temperature during operation. A circulation of steam through the spaces A is obtained by means of one or more perforations of holes B formed in alternate discs adjacent to the hub. A flow of steam, therefore, takes place, as indicated by the arrows. In this manner fresh steam is con-

N°173,989



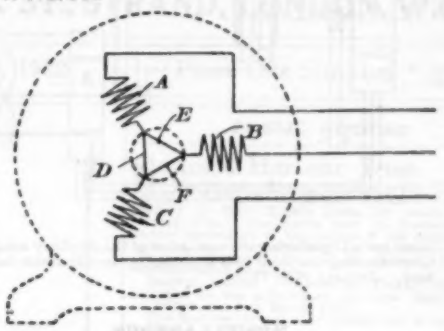
tinually brought into contact with both sides of all the discs, and the spaces between the discs are not filled with stagnant steam. Without these special steam passages through the discs it has been found that when a turbine is started up or when changes of load occur or when the exhaust of the turbine is suddenly changed over from vacuum to atmosphere, considerable differences in temperature occur in various portions of the disc, and these differences of temperature may cause abnormal stress to be set up in the discs.—*January 19th*, 1922.

DYNAMOS AND MOTORS.

173,889. October 12th, 1920.—DISPOSITION OF SAFETY DEVICES AND CONNECTIONS IN POLYPHASE GENERATORS OR OTHER ELECTRICAL APPARATUS, Karl Richard Jhamuotila, of Städtische Elektricitätswerke, Helsingfors, Finland.

This invention relates to a scheme for protecting three-phase generators, motors, &c., and consists of placing safety devices at an open neutral point. In the drawing at the open neutral point of the star-connected phases A, B, and C the safety devices D, E, and F form a triangle. It will be apparent that the safety devices and connections are loaded only by a part of the line current of the phases, which part amounts to $\frac{1}{\sqrt{3}}$ of the line current, and, accordingly, the safety devices and connections may be diminished in size down to the $\frac{1}{\sqrt{3}}$ of the size hitherto employed. With this arrangement it is possible by the employment of fusible safety devices to realise with certainty a simultaneous circuit breaking of all phases of the machine or apparatus because, if one safety device has been fused, the two other safety devices, which are normally loaded with $\frac{1}{\sqrt{3}}$ of the line current

N°173,889



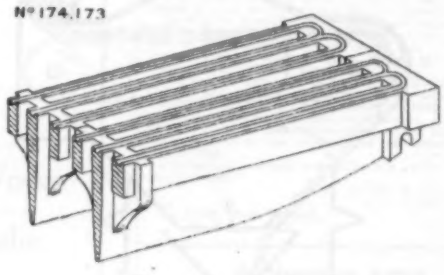
will then receive the full current and will fuse immediately. A further advantage of the invention is that high-tension machines can be protected by fusible safety devices instead of by switches.—*January 12th*, 1922.

HEATING AND VENTILATING.

174,173. October 18th, 1920.—FIRE-BARS, J. Jones, 30, Caithness-drive, Liscard, Cheshire, and A. McConwell and Co., Limited, 60, Drury-buildings, 21, Water-street, Liverpool.

These bars are cast in units of three bars each, of which the centre bar is comparatively deep and has a thin fin. The side

N°174,173



bars are connected with the centre bar by brackets and grooves are formed on the tops of the bars. The construction is said to increase the heating of the air before it reaches the fire and to lengthen the life of the bars. The illustration shows a short section of two bars.—*January 18th*, 1922.

TESTING AND MEASURING INSTRUMENTS.

173,949. November 29th, 1920.—IMPROVEMENTS IN LIQUID METERS, Walter George Kent, of 199, High Holborn.

This invention relates to liquid meters of the type in which the liquid to be measured impinges upon the vanes of a wheel which actuates a counter. When the flow of liquid in such meters is very small the indication of the meter is inaccurate, and the object of the invention is to overcome this trouble. The liquid to be measured after passing through a strainer A enters the

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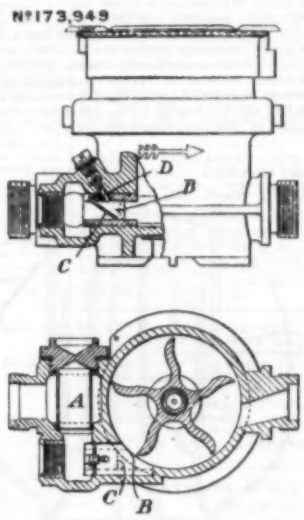


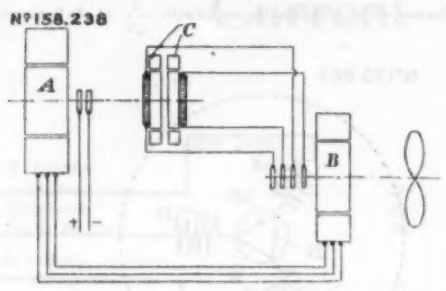
measuring chamber through an inlet B in which is a gate valve C pivoted on a horizontal pin. An adjustable stop D is provided above the gate to limit the opening. When the flow is small the gate will only be opened slightly and a small jet of liquid will impinge upon the measuring rotor at a higher velocity than would happen if there were no gate and the whole area of the inlet were free to supply the required flow. In this way the jet produces an effect upon the rotor sufficiently great to ensure the meter registering.—*January 19th*, 1922.

SHIPS AND BOATS.

158,238. January 10th, 1921.—IMPROVEMENTS IN AND RELATING TO ELECTRIC SYSTEMS OF SHIP PROPULSION AND THE LIKE, Société des Ateliers de Constructions Electriques du Nord et de l'Est, of 75, Boulevard Hausmann, Paris.

In the diagram A is the generator and B the motor which drives the propeller. The slip rings of the induction motor are connected to two auxiliary commutator machines C, which are coupled to the shaft of the generator A, and when the induction

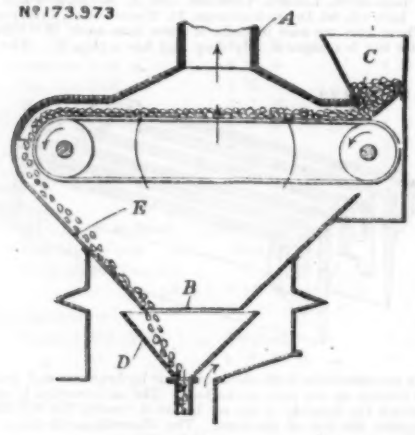
motor runs at a speed below the synchronous value, the power due to the slip is returned directly to the prime mover by means of the auxiliary machines C, the speed of the induction motor B being varied by altering the excitation of the auxiliary machines C by shunting the main field windings by an adjustable inductance.—*January 26th*, 1922.



MISCELLANEOUS.

173,973. January 4th, 1921.—Improvements in or relating to Fuel Preheating Devices, Merz and McLellan, of Collingwood-buildings, Newcastle-upon-Tyne, and Edmund George Weeks, of 1, Tynedale-avenue, Monkseaton, Northumberland.

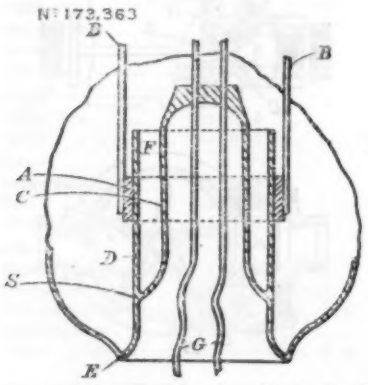
The preheater casing has an outlet flue A at the top and a discharge opening B at the bottom. Within the casing is an endless chain conveyor and a hopper C feeds the fuel on to this conveyor.



Hot waste flue gases pass into the casing by way of the space between the conical receiver D and the casing E. The heated gases therefore pass upward through the casing into the flue A, and in doing so impart heat to the fuel on the conveyor.—*January 19th*, 1922.

173,363. October 16th, 1920.—Improvements in Vacuum or Low-pressure Bulb Electron-discharge Apparatus, The General Electric Company, of Brook Green, Hammersmith, and Charles Frederick Trippe, of the same address.

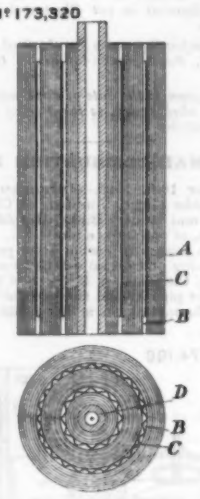
This invention relates to thermionic valves, and more particularly to devices of this kind having a glass re-entrant foot tube which forms a closure for one end of the exhausted bulb and through which the leading-in wires for the filament or other electrode are sealed, and which is utilised to carry attachments inside the bulb, namely, bands embracing the foot tube, to which supports for other electrodes within the bulb are connected. It has been found that where such attachments within the bulb are composed of metal, there is in certain circumstances a tendency for the difference in potential existing between the attachments and that part of the leading-in wires which is outside the bulb to cause an arc or discharge through the glass between them,



and the object of the present invention is to overcome this trouble. One method of carrying out the invention is illustrated. The metal band A which carries the supporting arms B B is attached to a cylindrical insulating carrier D of glass surrounding at a distance the foot tube C within the bulb. The inner end of the carrier D is open whilst its outer end is sealed to the bulb at E, and the foot tube C is sealed within the carrier at S so as to close the bulb. It will be seen that an annular vacuum space F is by this arrangement interposed between the walls of the foot tube and carrier D, and it is found in practice that the insulation due to the existence of the vacuum space F suffices to prevent the passage of any electric discharge between the band A and the leading-in wires G outside the bulb.—*January 5th*, 1922.

173,320. April 26th, 1921.—Improvements in or connected with Electrical Condensers, The British Insulated and Helsby Cables, Limited, Prescot; Ernest Arthur Baylis, of the Oaks, Helsby; and Harold Higham, of Britannia Works, Helsby.

Paper and metal foil A are rolled together in the well-known manner, and spaces B are provided to separate the sections. The liquid dielectric in the container is free to pass through these spaces. By means of corrugated cardboard C the spaces B are divided into triangular channels as shown. The body of the condenser is wound on a hollow core D of paper. A detailed description of the method of constructing the condenser is given.—*December 29th*, 1921.



Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

British Non-ferrous Metals Research Association.—Queen's Hotel, Birmingham. Annual meeting. 12.50 p.m.

Junior Institution of Engineers.—Caxton Hall, S.W. Lecturette, "Factory Administration," by Mr. E. T. Elbourne. 8 p.m.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Informal meeting. "Spiral Bevel *v.* Straight-tooth Bevel," by Mr. A. P. Bale. 7 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Microscopic Parasites and their Carriers," by Mr. C. Morley Wenyon. 9 p.m.

Institution of Locomotive Engineers.—College of Technology, Manchester.—Paper, "Modern Production and Costing Methods as Applied to Locomotive Engineering," by Mr. A. E. Howell. 7.30 p.m.

SATURDAY, MARCH 4th.

Institution of Locomotive Engineers.—Caxton Hall, S.W. 1. "Lubrication of the Modern Locomotive," by Mr. J. Clayton. 2.15 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Lecture I., "Radioactivity," by Sir Ernest Rutherford. 3 p.m.

Institution of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. Paper, "Cupola Practice," by Mr. J. Wood. 4 p.m.

Association of Engineering and Shipbuilding Draughtsmen: Merseyside Branch.—University, Engineering Building, Liverpool. "Elements of Diesel Engine Design," by Mr. D. Bruce. 7.30 p.m.

MONDAY, MARCH 6th.

Bradford Engineering Society.—Bradford Technical College. "The Magneto," by Mr. S. J. Young. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture III., "The Mechanical Design of Scientific Instruments," by Professor A. F. C. Pollard. 8 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. General meeting. 5 p.m.

Society of Engineers.—Geological Society, Burlington House, W. Paper, "The Testing of Small Electrical Plant," by Dr. C. V. Drysdale. 5.30 p.m.

The Petter Engineering Society.—Petter's Institute, 28, Kingston, Yeovil. "The Large Horizontal Gas Engine and its Applications," by Mr. H. Thackeray. 8 p.m.

TUESDAY, MARCH 7th.

Institution of Civil Engineers.—Great George-street, S.W. 1. Paper, "The Improvement of the Port of Valparaiso," by Messrs. A. C. Walsh and W. F. Stanton. 6 p.m.

Institution of British Foundrymen: Burnley Section.—Municipal College, Ormerod-road, Burnley. Paper, "Melting Steel and Cast Iron together in the Cupola," by Mr. J. Hogg. 7.15 p.m.

Institution of Electrical Engineers: South Midland Centre, Students' Section.—University, Edgbaston. Paper, "The Measurement of Flux Density in the Air Path of a Magnetic Circuit," by Mr. W. P. Couly. 7.30 p.m.

Institute of Marine Engineers.—The Minories, Tower Hill, E. 1. "On the Trail in Mexico," by Mr. C. Williamson Milne. Lantern. Ladies' night. 6.30 p.m.

WEDNESDAY, MARCH 8th.

Institution of Automobile Engineers.—Institution of Mechanical Engineers. Paper, "The Design and Function of Laminated Automobile Suspension Springs," by Mr. A. A. Remington. 8 p.m.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Annual general meeting. "Notes on the Corrosion and Protection of Condenser Tubes," by Mr. G. D. Bengough, 10 a.m.; "The Internal Mechanism of Cold Work and Recrystallisation in Cupro-nickel," by Mr. Frank Adcock; "The Effect of Impurities on Recrystallisation and Grain Growth," by the Research Staff of the General Electric Company, London; "Further Studies in Season Cracking and its Prevention: Condenser Tubes," by Dr. H. Moore and Mr. S. Beckinsale, 2.30 p.m. Annual dinner, Trocadero Restaurant, 7.30 p.m. for 8 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Proper Functions of Trade Unions," by Mr. W. A. Appleton. 8 p.m.

Association of Engineers-in-Charge.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper, "Thermal Efficiency of Small Power Stations and Methods of Comparison," by Mr. A. Hugh Seabrook. 7.30 p.m.

Machine Tool Users' Association.—Trocadero, Piccadilly-circus. Annual dinner. (Annual meeting at Trocadero on same day at 2.30 p.m.) 6.30 for 7 p.m.

Thornycroft Engineering Society.—Works Canteen, Basingstoke. "Present-day Manufacture of Gears," by Mr. T. H. Fowler. 7 p.m.

Industrial League and Council.—Caxton Hall, S.W. 1. —"The Personal Factor in Industry," by Miss B. Voysey. 7.30 p.m.

THURSDAY, MARCH 9th.

Faraday Society and the Oil and Colour Chemists Association.—Joint meeting at Chemical Society, Burlington House, W. 1. Papers on "The Properties of Powders," by Messrs. L. C. McHatton, C. A. Klein, W. J. Palmer, and R. W. Whymper; Dr. J. W. French and R. S. Morrell; Professor T. Martin Lowry and P. G. S. Boswell. 8 p.m.

Institute of Metals: London Local Section.—Sir John Cass Technical Institute, Jewry-street, Aldgate, E.C. 3. "Microstructure and Physical Properties of Alloys," by Dr. D. Hanson. 8 p.m.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Annual general meeting. "The Rate of Combination of Copper and Phosphorus at Various Temperatures," by Professor C. A. Edwards and Mr. A. J. Murphy; "Note on Some Cases of Failure in 'Aluminium' Alloys," by Dr. W. Rosenhain; "Some Mechanical Properties of the Nickel-silvers," by Professor F. C. Thompson and Mr. Edwin Whitehead; "A Further Study of the Alloys of Aluminium and Zinc," by Dr. D. Hanson and Marie L. V. Gayler, M.Sc.; "Note on the Assay of Gold Bullion," by Mr. Arthur Westwood. 10 a.m.

FRIDAY, MARCH 10th.

Junior Institution of Engineers.—Caxton Hall, S.W. 1. Paper, "Friction," by Mr. C. Hubert Plant. 8 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Problems in the Variability of Spectra," by Professor T. R. Merton. 9 p.m.

Manchester Association of Engineers.—Memorial Hall, Albert-square, Manchester. Paper, "Recent Developments on the Manchester Ship Canal," by Mr. Wm. Fox. 7 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Lecture Theatre, Literary and Philosophical Society, Newcastle-on-Tyne. "Diesel Engine Design," by Mr. Paul Belyavin. 6.30 p.m.

Junior Institution of Engineers: North-Eastern Section.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Special meeting. "Some Impressions of America, with special reference to Engineering Practice," by Dr. J. R. Beard. 7 p.m.

SATURDAY, MARCH 11th.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Lecture II., "Radioactivity," by Sir Ernest Rutherford.

Keighley Association of Engineers.—Assembly Rooms of the Cycling Club, Cavendish-street. "Foundry Practice," by Mr. C. Webster. 6.30 p.m.

MONDAY, MARCH 13th.

Institution of Locomotive Engineers.—Leeds Y.M.C.A., Albion-place. Paper, "Notes on the Influence of Design on Express Locomotive Performance," by Mr. C. J. Allen. 7 p.m.

Institute of Transport.—Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Paper, "Railway Problems in China and Australia," by Mr. T. R. Johnson. 5.30 p.m.

WEDNESDAY, MARCH 15th.

Institution of Civil Engineers: Manchester and District Association.—Paper on "The Engineering Aspect of the Heating and Ventilating of Buildings," by Mr. J. N. Ellis. 6 p.m.

Institution of Civil Engineers: Students' Section.—Great George-street, S.W. 1. Lecture I., Vernon Harcourt Lectures, "The Great Ship Canals of the World," by Mr. Gerald Fitzgibbon. 6 p.m.

FRIDAY, MARCH 17th.

Faraday House Old Students' Association.—Queen's Hotel, Leicester-square, W.C. 2. Smoking concert. 8 p.m.

Junior Institution of Engineers.—Caxton Hall, S.W. 1. Lecturette, "Power Factor Improvement," by Mr. G. H. Ayres. 8 p.m.

Institute of Transport.—Royal Society of Arts, John-street, Adelphi, W.C. Lecture, "The Operation of an Omnibus Company, with reference to Capacity and Cost under Given Conditions," by Mr. F. Pick. 5 p.m.

WEDNESDAY, MARCH 22nd.

Institution of Civil Engineers: Manchester and District Association.—Paper on "Earth Pressures and Retaining Walls," by Mr. W. B. Wignall. 6 p.m.

SATURDAY, MARCH 25th.

Institution of Municipal and County Engineers: North-Western District.—Council Chamber, Town Hall, Blackpool. 11 a.m.

TUESDAY, MARCH 28th.

The Engineers' Club.—Manchester. Annual general meeting. 1.45 p.m.

WEDNESDAY, MAY 3rd.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May lecture: "The Relation of the Elements," by Sir Ernest Rutherford. 8 p.m.

THURSDAY and FRIDAY, MAY 4th and 5th.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. Annual dinner, Thursday, May 4th, at Connaught Rooms, Great Queen-street, W.C.